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**U.S. Army
Environmental
Center**

**DEMONSTRATION PLAN
FOR
PHYTOREMEDIATION OF EXPLOSIVES
CONTAMINATED GROUNDWATER IN
CONSTRUCTED WETLANDS**

**at
MILAN ARMY AMMUNITION PLANT
Milan, Tennessee**

Volume I of II

Prepared for
**U.S. ARMY ENVIRONMENTAL CENTER
Aberdeen Proving Ground, Maryland 21010-5401**

Funded Through



**U.S. Department of Defense
Environmental Security
Technology Certification Program**

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Prepared by
**Tennessee Valley Authority
Environmental Research Center
Muscle Shoals, Alabama 35660-1010**

January 1996

**TVA Contract No. TV-88826V
Report No. SFIM-AEC-ET-CR-95090**

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at Milan Army Ammunition Plant**

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**U.S. Army Environmental Center
Environmental Technology Division
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POC: Ms. Darlene Bader**

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NOTICE

This Demonstration Plan for Phytoremediation of Explosive-Contaminated Groundwater in Constructed Wetlands was prepared by employees of the Tennessee Valley Authority (TVA) loaned to the U.S. Army Environmental Center (USAEC) at Aberdeen Proving Ground, Maryland, 21010-5401, pursuant to the provisions of TVA Contract TV-88826V and Military Interdepartmental Purchase Order Request (MIPR) MIPRA485 dated 13 September, 1995.

Under that agreement and MIPR, TVA provided the services mutually agreed upon as loaned employees. In regard to the services provided by the TVA employees, sections d and e of the contract and MIPR state as follows:

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ABBREVIATIONS

AAP	-Army Ammunition Plant
AFUDC	-Allowance for Funds Used During Construction
ALEA	-Analytical Laboratory of Environmental Applications
BOD	-Biochemical Oxygen Demand
CE	-Capillary Electrophoresis
COD	-Chemical Oxygen Demand
DANT	-Diaminonitrotoluene
DNT	-Dinitrotoluene
DO	-Dissolved Oxygen
DoD	-Department of Defense
EC	-Electrical Conductivity
ECWTP	-Explosive-Contaminated Wastewater Treatment Plants
EPA	-Environmental Protection Agency
EPDM	-Ethylene Propylene Diene Monomer
ESTCP	-Environmental Security Technology Certification Program
FIA	-Flow Injection Analyzer
GAC	-Granular Activated Carbon
GOCO	-Government Owned Contractor Operated
gpm	-Gallons per Minute
HPLC	-High Performance Liquid Chromatography
IC	-Ion Chromatograph
ICP	-Inductively Coupled Plasma
HMX	-Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
LAP	-Load, Assemble, Pack
LMOS	-Lockheed Martin Ordnance Systems
M	-Million
MAAP	-Milan Army Ammunition Plant
MDL	-Method Detection Limit
MEV	-Million Electron Volt
MMOS	-Martin Marietta Ordnance Systems, Inc.
MOD	-Milan Ordnance Depot
NH ₄ -N	-Ammonia Nitrogen
NO ₃	-Nitrate
(NO ₃ +NO ₂)-N	-Nitrate + Nitrite Nitrogen
NPDES	-National Pollutant Discharge Elimination System
PO ₄	-Orthophosphate
PO ₄ -P	-Orthophosphate - Phosphorus
PVC	-Poly Vinyl Chloride
QA	-Quality Assurance
QC	-Quality Control
RDX	-Hexahydro-1,3,5-trinitro-1,3,5-triazine

R&D	-Research and Development
STP	-Sewage Treatment Plant
TAT	-Triaminotoluene
TKN	-Total Kjeldahl Nitrogen
TNB	-Trinitrobenzene
TNT	-2,4,6 Trinitrotoluene
TOC	-Total Organic Carbon
TVA	-Tennessee Valley Authority
USAEC	-U.S. Army Environmental Center
USEPA	-United States Environmental Protection Agency
UT	-University of Tennessee
UV	-Ultraviolet
WCOP	-Wolf Creek Ordnance Plant
WES	-Waterways Experiment Station

SECTION 1.0

INTRODUCTION

1.1 Background

The fate of explosive residues in soil and groundwater is a concern to the Department of Defense (DoD). To date numerous DoD sites in the U.S. have been identified as having explosives-contaminated groundwater, and additional sites continue to be identified. Hence, the Army has prioritized "Explosives in Groundwater" as the fourth highest requirement in the area of environmental restoration research and development. The Army Requirements Statement being addressed include explosives in groundwater, organics in groundwater, and solvents in groundwater (Reference: ESTCP proposal guidance). Explosives contaminants found at the DoD sites include: TNT, RDX, HMX, and DNT. Because the explosives-contaminated groundwater is affecting drinking water supplies both on and off several installations, the DoD is currently providing potable water to affected communities.

As part of the DoD's program to combat groundwater contamination, the Department of Defense's Environmental Security Technology Certification Program (ESTCP) has funded a project to demonstrate phytoremediation (i.e., vegetation induced remediation) of explosives-contaminated groundwater using constructed wetlands and plant lagoons. This project is being executed under a partnering agreement among the:

- U.S. Army Environmental Center (USAEC)
- Tennessee Valley Authority (TVA)
- USAEC's Waterways Experiment Station (WES)

The USAEC, as the lead agency, has selected Milan Army Ammunition Plant (MAAP), located near Milan, Tennessee, as the demonstration site. The other groups are providing technical expertise in phytoremediation and in the design, construction, and operation of constructed wetlands and plant lagoons.

The project is being executed in two phases. Phase I involved a series of plant screening and treatability studies. During Phase I, standard methods were developed to evaluate the ability of aquatic macrophytes (large-aquatic-plants) to lower the contaminant levels of TNT, RDX, and related compounds in explosives-contaminated water. Then, a variety of submergent and emergent aquatic macrophytes were screened for their ability to remediate the contaminated water. Finally, treatability studies were undertaken to test the performance of various wetland configurations. In Phase II, the field demonstration system will be designed, installed at MAAP, monitored, and evaluated from both a technical and economic perspective.

This document is intended to serve as the demonstration plan for the operation and sampling portion of the field demonstration in Phase II. Although, other aspects of Phase II (e.g., design, construction, economic data collection, etc.) are also addressed.

1.2 Current Practice and Alternatives

The current practice is for contaminated groundwater to be treated by pumping groundwater to the surface, at rates up to 500,000 gallons per week (50 gpm), and passing the water through columns of granular activated carbon (GAC). The disadvantage of this technology is that the explosive compounds are concentrated without being degraded. The compounds absorbed onto the carbon granules require further treatment. Projected costs per contaminated site are as high as \$8 M for construction and \$1.5 M annually (30 years), for operations and maintenance. In addition, at some installations, the Army is currently spending \$1-5 M per site to provide alternative drinking water supplies for affected communities (Reference: ESTCP proposal).

Alternate treatments involve oxidation of the explosives compounds with ultraviolet (UV) radiation or a combination of hydrogen peroxide and ozone. These technologies have the advantage of degrading the contaminants, but they are energy intensive and still require that the effluent stream be polished with activated carbon to remove remaining by-products.

A third approach is the use of constructed wetlands/plant lagoons. Constructed wetland and plant lagoon systems are well suited for removing a broad range of contaminants from surface and groundwater sources. These natural-based systems are appealing as remediation technologies due to:

- Aesthetics
- Ease of operation
- Low capital and operating expenses

Degradation pathways in these systems are complex due to variations in the contaminants involved and the nature of the wetland/lagoon. But wetland/lagoon designs are generally based on the combined action of higher aquatic plants (emergent and/or submergent), and microbial populations composed of algae, bacteria, and fungi. Important parameters that are known to influence degradation pathways and kinetic degradation rates include:

- Temperature
- pH
- Dissolved oxygen concentration
- Redox potential
- Nutrient mix

Within the past two years, several aquatic-based treatment systems have been evaluated--in microcosm-scale--for their ability to remediate groundwater contaminated with TNT, RDX, HMX, and their associated by-products. Relevant activities include:

- Scientists at the EPA National Exposure Research Laboratory (Athens, Georgia) isolated two plant enzymes, nitroreductase and laccase, from various aquatic and terrestrial plants. These enzymes rapidly degrade TNT, TNT by-products, and, to a lesser extent, RDX (EPA Annual Report, 1994, Lee Wolfe, personal communication).
- Scientists at the Waterways Experiment Station (Vicksburg, Mississippi) are screening additional submergent aquatic plants for similar enzyme activity.
- Scientists at TVA's Constructed Wetlands R&D Center (Muscle Shoals, Alabama) investigated the utility of anaerobic and aerobic constructed wetlands for degrading TNT, RDX, and their by-products. Emergent aquatic plants are also being screened for their ability to degrade TNT and RDX.

These studies are the basis for the design of the demonstration-scale wetland-based remediation systems at MAAP.

1.3 Project Objectives

The objective of the demonstration is to design, operate, and demonstrate the effectiveness of constructed wetlands/plant lagoons in remediating explosive-contaminated groundwater; and to evaluate and compare, with current technologies, the technical feasibility of the respective wetland-based treatment systems for remediating explosives-contaminated groundwater at an Army ammunition plant.

Evaluation of treatment efficacy will be based on removal efficiencies for the following:

- Specific explosives
- Their known by-products
- Biochemical and chemical oxygen demand
- Suspended solids
- Selected nutrients

Economic feasibility will be based on cost-benefit ratio analyses of these and other commercial remediation systems.

1.4 Approach

This section covers TVA responsibilities in Phase II, which include:

- Developing the demonstration test plan
- Designing, constructing, and operating the field-scale constructed wetland and plant lagoon demonstration systems at MAAP
- Preparing the demonstration results report

Two demonstration-scale systems (gravel-based constructed wetlands and a plant lagoons) were designed in the fall of 1995 to be installed on a parcel of land at MAAP's area K. The demonstration facility will be constructed during the second quarter of FY 96, with selected plant species being planted during April 1996, which will coincide with the start of the demonstration. The demonstration is proposed to operate through July 1997 to enable data collection during all four seasons and the ensuing summer months of 1997. The 1997 summer data will be very important in that, during the summer of 1996, the systems will be acclimating and the plants will not be well established, therefore, not yielding consistent performance data.

An area adjacent to building K-100 was selected for use in the demonstration. The demonstration site is located in area A, Figure 1, to the east of building K-100. Detailed design information about the wetland/lagoon systems is provided in section 3.0 (technology description section).

Well MI-146 will be the source of contaminated groundwater for the two demonstration systems. Sample analysis of the groundwater from well MI-146 on October 4, 1995, indicated the following levels (mg/l) of contamination: HMX--0.178; RDX--2.98; TNB--0.15; TNT--1.99; 2,4DNT--0.026. Nitrate concentrations were also reported at 10.0 mg NO₃-N/L.

During the course of the demonstration, water, plant, and substrate samples will be collected routinely on a biweekly, bimonthly, and quarterly basis, respectively. Water samples will be analyzed for the following:

- Explosives
- Explosive by-products
- Nutrients
- Dissolved oxygen
- pH
- Temperature
- Suspended solids
- Metals

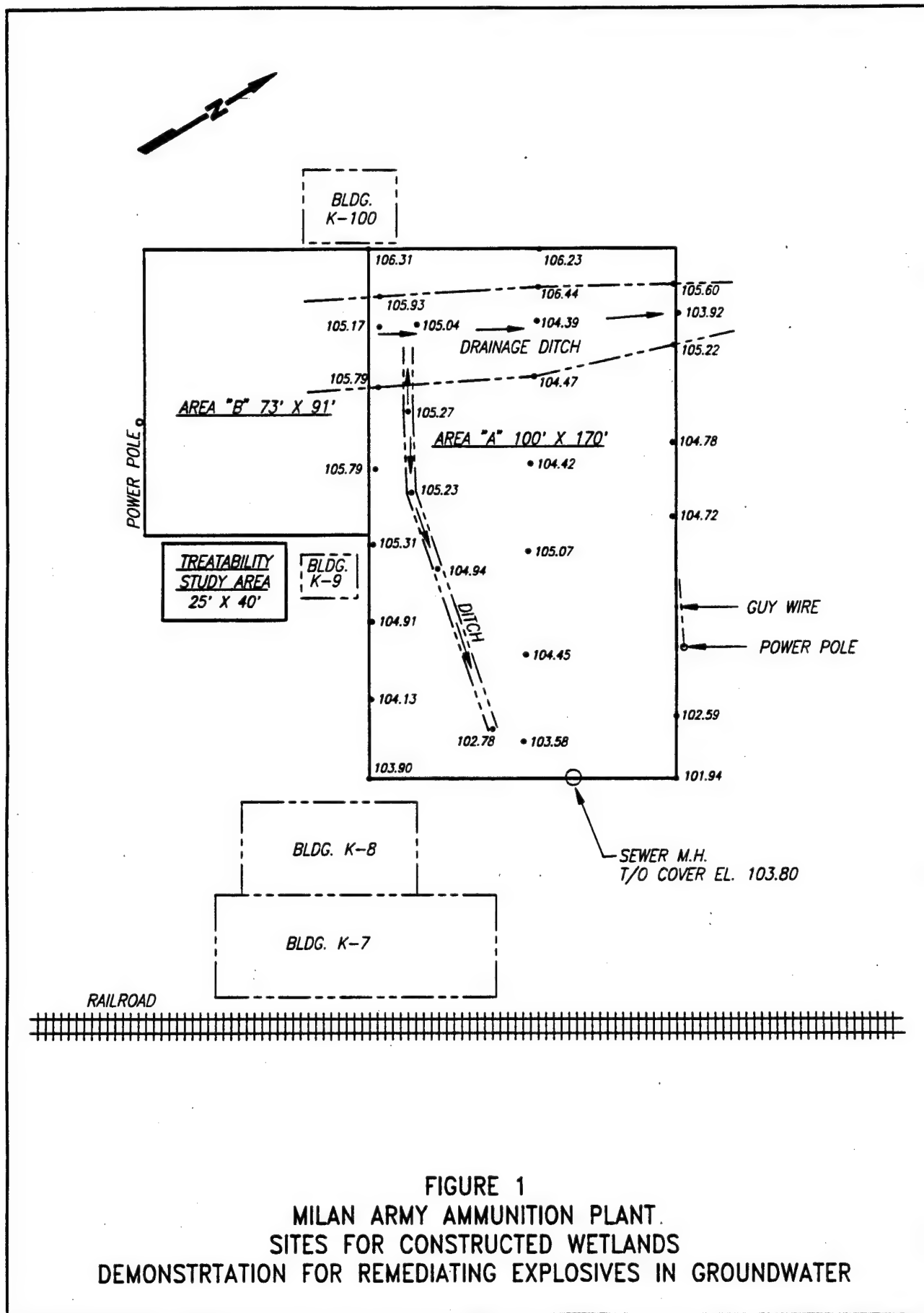


FIGURE 1
MILAN ARMY AMMUNITION PLANT.
SITES FOR CONSTRUCTED WETLANDS
DEMONSTRATION FOR REMEDIATING EXPLOSIVES IN GROUNDWATER

- Chlorides
- Redox potential
- Electrical conductivity
- Chemical oxygen demand
- Biochemical oxygen demand

Intensive sampling will be conducted every two months to quantify the removal kinetics. During this period plant and sediment samples will be collected in addition to the water samples described above. Plant tissue will be evaluated with respect to root-shoot weights and morphology, nutrient content, dry matter content, explosives content and explosive by-products. Sediment (including gravel) samples will be analyzed for explosives content and explosive by-products.

TVA will have other responsibilities including:

- Performing all of the analytical analyses for TVA's Phase I activities.
- Performing compliance analysis and analyzing bimonthly split samples for the WES/Georgia Tech. Phase I treatability studies.
- All Phase II field-demonstration activities.
- Performing *Hyaella azteca*, *Cerodaphnia dubia*, *Pimephales Promelas*, and *Chironomus tentans* toxicity testing in gravel and water to access toxicity levels in the overall field demonstration.

1.5 Schedule

A GANTT chart of TVA related activities is provided in Table 1. Phase II began on August 1, 1995, and is scheduled to be complete by December 31, 1997. As indicated on the GANTT chart, there is some overlap between Phase I and Phase II. Phase I is to be complete by June 28, 1996.

PHYTOREMEDIATION OF EXPLOSIVES CONTAMINATED GROUNDWATER IN CONSTRUCTED WETLANDS

at
Milan Army Ammunition Plant

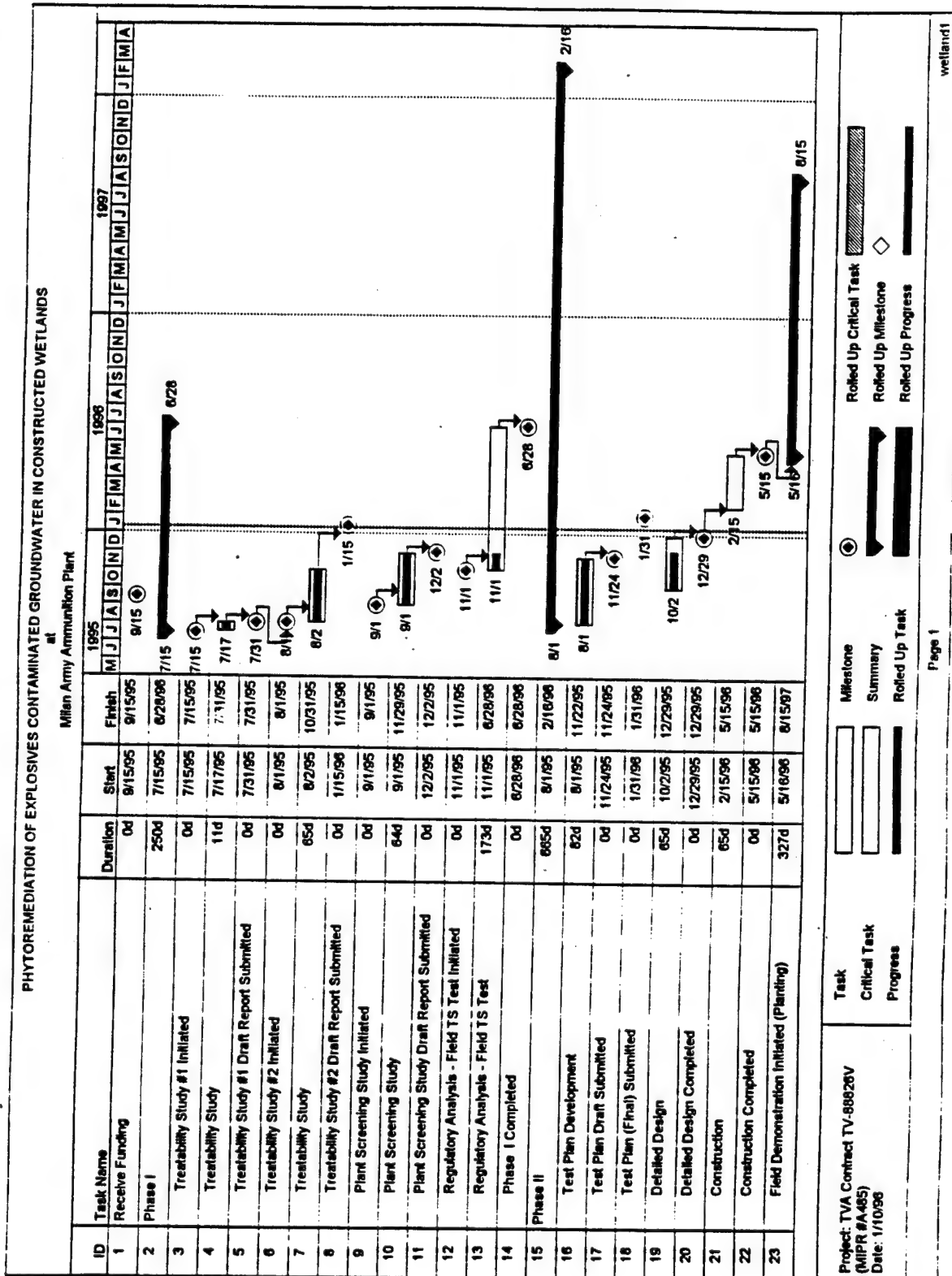


Table 1
GANTT Chart for Wetlands Project

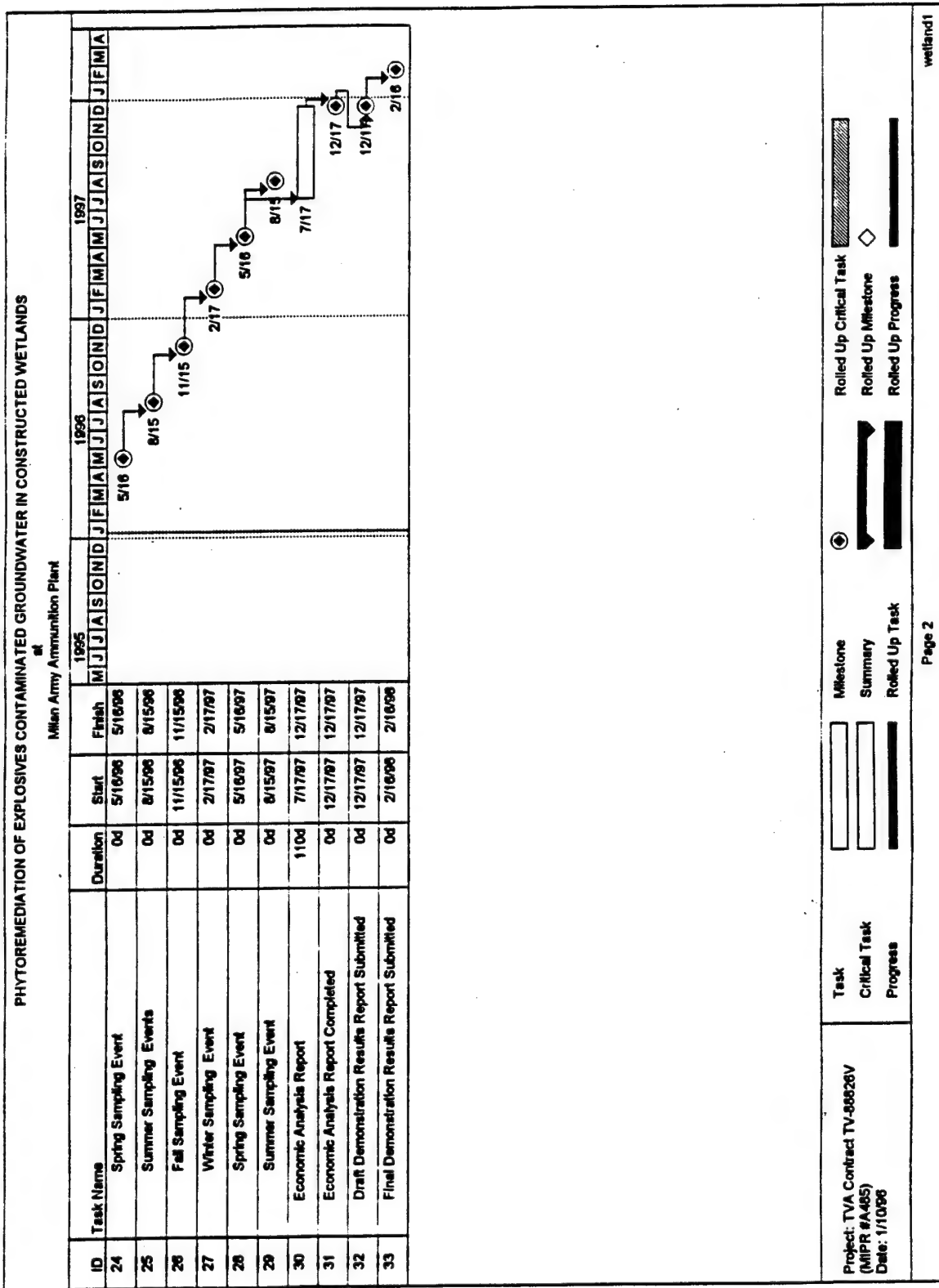


Table 1 (Cont)
GANTT Chart for Wetlands Project

SECTION 2.0

DEMONSTRATION SITE DESCRIPTION

2.1 Site Location

The demonstration will be conducted at area K at MAAP. MAAP is located in portions of Gibson and Carrol Counties in western Tennessee, Figure 2. The city of Milan lies approximately one mile west of MAAP, Humboldt lies 17 miles southwest, Trenton lies 18 miles northwest, and Jackson lies 28 miles south. The site is approximately 50 miles east of the Mississippi River. MAAP has a total size of 22,436 acres and is bordered on the northeast and east by land owned by the Tennessee National Guard and on the northwest by lands owned by the city of Milan and the University of Tennessee.

2.2 Site Description

MAAP facilities include nine active ammunition LAP (load, assemble, pack) lines, one washout/rework line, one experimental line, one X-ray facility, one test area, two shop maintenance areas, storage areas, demolition and burning grounds area, an administrative area, a family housing area, and recreational facilities. In addition, there are medical facilities, fire/ambulance stations, ten high pressure heating/process steam plants, 16 low pressure heating plants, one solar pond, and seven explosives-contaminated wastewater treatment plants (ECWTPs). There are two sewage treatment plant (STPs) located on the facility; the Wolf Creek Ordnance Plant (WCOP) STP in the northern portion of the site and the Milan Ordnance Depot (MOD) STP in the south. A laundry facility for clothing used by on-site personnel while working with explosives/propellants is located in Area J. Near K-line, there is a large power plant, a coal pile, and an evaporation pond for the coal pile runoff.

Of the fourteen process areas active by the end of World War II, only nine lines (A, B, D, H, I, O, V, X, and Z) are in use today. In the past, waste water from various production activities in the lines was discharged to open ditches that drained from sumps or surface impoundments

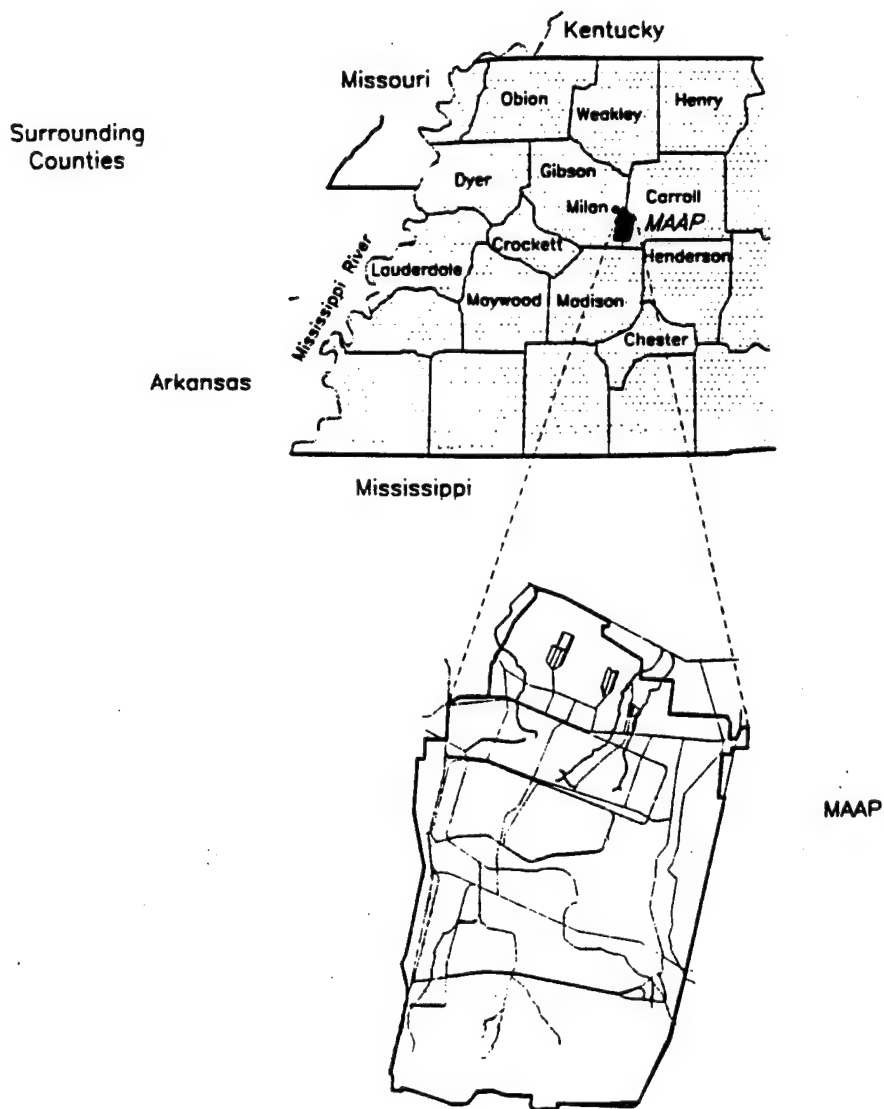
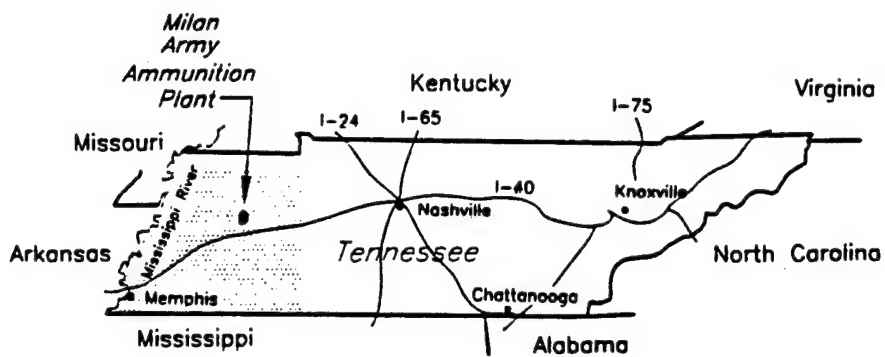


Figure 2
Location of MAAP in Western Tennessee

into both intermittent and perennial streams and rivers. Currently, MAAP treats all process water from lines that generate explosives-contaminated wastewater in the seven ECWTPs. This wastewater is processed by a packed tower activated carbon absorption system and discharged under the authority of a National Pollutant Discharge Elimination System (NPDES) permit.

Acreage not designated as a LAP lines are often used for agricultural purposes.

Approximately 13,600 acres within the MAAP boundary are leased for agricultural use.

Approximately 3,984 acres are used as cropland. Cotton, corn, and soybeans are the main crops, with smaller amounts of grain sorghum and wheat also grown. In 1990, there were 2,746 head of cattle grazing on the facility. The cattle graze between April and November on approximately 8,700 acres. In addition, MAAP has more than 6,000 acres of managed timberland.

2.3 Site History

2.3.1 Current Operations

MAAP is a government-owned-contractor-operated (GOCO) military industrial installation under the jurisdiction of the Commanding General, Headquarters, United States Army Industrial Operations Command. MAAP is operated by Lockheed Martin Ordnance Systems, Inc. The current level of employment is approximately 1,200 people.

The current mission includes:

- The loading, assembling, and packaging of conventional ammunition items as assigned
- Operation and maintenance, as directed, of active facilities in support of current operations
- Maintenance or layaway, in accordance with regulations for standby facilities, including any machinery and packaged items received from industry, in such condition as will permit rehabilitation and resumption of production within the time limits prescribed

- Receipt, surveillance, maintenance, renovation, demilitarization, salvage, storage, and issue of assigned field service stocks and V and W group items of industrial stocks as required or directed
- Procurement, receipt, storage, and issue of necessary supplies, equipment, components, and essential materials

2.3.2 Past Operations

Construction of MAAP (authorized on December 18, 1940) started in January 1941, and was completed in January 1942. The H. K. Ferguson Engineering Company, Cleveland, Ohio, and the Oman Construction Company, Nashville Tennessee, formed the Oman Construction Company to design and construct the installation. The original land area encompassed 28,521.4 acres. The installation currently encompasses 22,436 acres, as tracts of land have been sold, deeded, leased, or transferred. Approximately 548 acres enclose the various production lines; while the storage areas total 7,930 acres; and approximately 1,395 acres are used for administrative, shop maintenance, housing, recreation, and other functions. Other acreage is necessary to allow safe distances between areas containing explosives.

Initially, the plant was divided into two separate units: Wolf Creek Ordnance Plant (WCOP) and the Milan Ordnance Depot (MOD). In July 1943, the Ordnance Plant and Depot merged into a single ordnance facility, the Milan Ordnance Center, and the Proctor and Gamble Defense Corporation became the operating contractor for the facility.

During World War II, the mission of the facility included the production of fuses, boosters, and complete rounds of both minor and major caliber ammunition; the operation of an ammonium nitrate plant; and the receipt, storage, and shipment of ammunition. Peak employment reached approximately 11,000 people.

Milan Ordnance Center was designated Milan Arsenal on October 30, 1945, and the following month, the plant reverted to government operation and was placed on standby status. The plant's mission then included receipt, storage, and processing of ammunition from overseas;

normal maintenance, surveillance, renovation, and demilitarization; and a limited amount of new production.

During the early part of the Korean Emergency, the Proctor and Gamble Defense Corporation assumed operation of the facility. On April 29, 1953, the plant was placed on active status and employment reached approximately 8,000 people. Principal changes to the plant's mission were the increased output of new ammunition, inclusion of experimental ammunition, and the Phase II Industrial Engineering Studies of all ordnance command loading plants.

Effective July 1, 1954, Milan Arsenal was designated a permanent installation. Also in 1954, production lines were placed on layaway due to sharp decreases in production schedules. In 1955, two more lines were placed on standby status. By 1957, production had ceased and only a small demilitarization program at B-line continued.

On October 1, 1957, the industrial activity of Milan Arsenal was placed on inactive status. An economy and austerity program was put into effect and remained until January 1, 1960, when the industrial portion of the Milan Arsenal returned to active status. Later that same month, the Proctor and Gamble Defense Corporation terminated their contract with the government, and Harvey Aluminum Sales, Inc., Torrance, California, became the operating contractor.

On November 2, 1961, the industrial portion of Milan Arsenal was designated Milan Ordnance Plant and the field service portion as Milan Depot Activity. The depot activities were discontinued on November 16, 1962; however, the field service mission is still being performed. On August 1, 1963, Milan Ordnance Plant became officially known as Milan Army Ammunition Plant.

During the 1960's, existing facilities were rehabilitated and the plant modernized to produce fuses, primers, delay plungers, delay elements, and boosters; 40mm, 60mm, 81mm, 105mm, 106mm, and 155mm ammunition; mine, grenade, and cluster bomb unit dispensers; demolition kits; shell metal parts; pelletizing explosives; and to renovate various items. Martin Marietta, Inc., gained controlling interest of Harvey Aluminum Sales, Inc., on December 22, 1969.

During 1971 Lines E, F, and H were placed on layaway. Production was transferred to other lines, and equipment used to produce metal shell parts was transferred to private industry.

In December 1975, production of items on Z line was canceled. Z line was reactivated in April 1992 and is currently on active status. In 1977, production of items from C line was transferred to B line. C line was then placed on standby status.

An extensive modernization program began in 1978 and continued through 1985. Production lines A, C, E, and Z were updated during this program. A project to automate the manufacture of 60mm and 81mm propellant increments at C line was also completed during this time. This project led to the development of a melting system at MAAP. Prove-out/production was completed in October 1983 and the line was placed on layaway in August 1984. Limited production of 60mm and 81mm mortar rounds was transferred to line D.

The X-ray facility at line V was built to consolidate the plant's X-ray operation in one location. Previously, X-ray facilities existed at C, D, and K lines. V line contains an underground 4 million electron volt (MEV) X-ray unit, a 2 MEV unit, and a 0.420 MEV unit, and a fluoroscope. This is the world's largest facility dedicated solely to non-destructive testing of ammunition.

Other upgrades to MAAP included the construction of explosives-contaminated wastewater treatment plants, (ECWTPs), built as six production lines under a contract issued by the U.S. Army Corps of Engineers (USACE). Construction began in October 1979 and was completed on March 13, 1981. An additional ECWTP was constructed in area J for pretreatment of the laundry wastewater. Construction began in April 1992 and was completed in November 1993. These plants remove explosive contaminants from the process water before discharge, using activated carbon filtration. These discharges are regularly monitored by an environmental laboratory constructed in 1980. The spent carbon generated by the ECWTPs is a listed hazardous waste (U.S. EPA number K0465). Spent carbon is stored in the hazardous waste storage igloos in area D before transport to an off-site treatment, storage, and disposal facility. Effective January 7, 1985, Martin Marietta Corporation sold its interest in the aluminum business and organized another company, Martin Marietta Ordnance Systems, Inc., (MMOS), to operate MAAP. In 1994, Martin Marietta Corporation became Lockheed Martin Ordnance Systems, Inc.

2.4 Site Characteristics

2.4.1 Climate

The MAAP area is located in a temperate climatic zone which averages 50 inches of rain per year. Average evaporation is 40 inches per year. The monthly mean temperature ranges from 40° F in the winter months to 80° F in July. The average frost-free season is 215 days per year.

2.4.2 Geology

Western Tennessee (including MAAP) lies on the eastern flank of the Upper Mississippi River Embayment. Structurally, the Embayment is a downwarped downfaulted trough whose axis approximates the present course of the Mississippi River. Sediments ranging in age from Cretaceous to Recent have been deposited in this trough during its complicated history which included advances and regressions of the sea. These sediment consist of sand, gravel, lignite, clay, chalk, and limestone units that vary in thickness.

MAAP is situated on the Memphis Sand of the Claiborne Group of Tertiary age in the Gulf Coastal Plain of Western Tennessee. The altitude and thickness of stratigraphic units beneath Milan, Tennessee are inferred on the cross section from data for observation wells in Gibson and Carroll counties. The Memphis Sand outcrops in a broad belt across western Tennessee, but, is covered in most places by fluvial deposits of Tertiary and Quaternary age and loess and alluvium of Quaternary age.

2.4.3 Topography

MAAP lies within the coastal plant province of the Mississippi Embayment. The topography of MAAP, and the surrounding area, is characterized by gently rolling hills with elevation ranging from approximately 590 feet at the southern facility boundary to approximately 320 feet at the northern boundary.

2.4.4 Soil Type

The surface soils at MAAP consist chiefly of a reddish-brown to yellow mottled silty clay that grades into a clay unit with depth. The soil types include the Memphis, Loring, Grenada, Calloway, Henry, Falaya, and Waverly soil associations. Based on topography, the Memphis and Loring series occur on higher elevations and are well-drained soils. The Henry soil series is somewhat poorly drained and is usually associated with flat terrain while the Falaya and Waverly occur in the low areas and are poorly drained.

Logs from borings drilled at the site indicate that the upper 12 to 15 feet of soil consists of reddish-brown to tan, silty, low-plasticity clay with some layers of sandy and highly plastic clay. Below these depths, sands with varying amounts of silts and clay have been encountered. Occasional gravel, up to 3/8 inch in diameter, has been encountered during boring operation. A more sandy alluvium of lesser thickness (5-10 feet) was observed in several areas near surface drainage features. Natural and artificial drainage systems have incised into the alluvium in several locations.

2.4.5 Surface Waters

Numerous perennial and ephemeral surface water features occur within MAAP and flow to the north-northwest. Wolf Creek, the largest interior drainage body, originates at the East Fork of Wolf Creek near Pine Lake at the southeastern boundary. Along with two other tributaries (Dry Creek and West Fork of Wolf Creek), Wolf Creek drains the southern and central portions of the installation. It exits along the northwest boundary and empties into the Rutherford Fork of the Obion River. The extreme southern portion of the installation drains south to the Middle Fork of the Forked Deer River. The northeastern portion of the installation drains to Halls Branch, Johns Creek, and the Rutherford Fork of the Obion River. The northern portion of MAAP contains several well-developed, ephemeral, natural drainage bodies (defined alphabetically as Ditches A through E) that join the Rutherford fork along the northern boundary of the installation. The two parent streams, the Forked Deer River and Obion River, empty into the Mississippi River about 60 miles west of MAAP.

2.4.6 Groundwaters

Sand in the Claiborne and Wilcox Groups are principal sources of groundwater in western Tennessee. At MAAP, the Memphis Sand of the Claiborne Group is the major aquifer. Although groundwater is also abundant in the underlying Wilcox and Cretaceous sediments (i.e., McNairy Sands), it has not been necessary to tap these deeper sources in most areas. Within the northern section of the MAAP, depth to groundwater ranges from 10 to 70 feet below land surface, depending on the topography and hydraulic location.

The major controls on groundwater movement in the Memphis Sand are the dip of the sediments, surface topography, and surface recharge and discharge patterns. Groundwater flow in the MAAP area is generally to the west, in the direction of regional dip of these sands, and can also trend to the north because of topographic influences. The gradient of the groundwater flow is estimated to be about 7.5 to 11 feet/mile to the northwest within the northern portion. On a general scale, there are no abrupt hydrologic boundaries in the aquifer. The formation is recognized as sand with clay rich zones which may locally alter vertical groundwater flow; stratification of the sediments tends to make vertical conductivity's lower than horizontal conductivity's. The sands range from very fine to very coarse-grained, and the grain size may vary both horizontally and vertically over short distances.

The clay units that dominate the stratigraphic section below the Wilcox Group to the top of the Cretaceous McNairy Sand are known as the Porters Creek Clay, the Clayton formation, and the Owl Creek formation. Collectively, these formation constitute a stratigraphic unit which is approximately 425 feet thick and begins approximately 250 feet below the surface at MAAP.

The McNairy Sand is an artesian aquifer that underlies the installation and begins approximately 500 feet below the Claiborne group. The McNairy Sand is approximately 200 feet thick near the Tennessee-Mississippi state line and contains cross-bedded, variegated sands with lenses and interbeds of clay and lignite. Clays are common to the McNairy sand and relatively large clay bodies occur stratigraphically near the middle of the formation.

2.4.7 Groundwater Contamination

In the past, wastewater from various production activities was discharged to open ditches that drained from sumps or surface impoundment into both intermittent and perennial streams. Discharge of wastewater to the open ditches was stopped in 1981. However, several of the ditches are thought to have been affected by past activities. Currently, the suspected source of existing groundwater contamination at MAAP is effluent drainage ditches from ammunition production lines prior to the 1980's.

Investigation of the existing ECWTPs indicate that the discharge from these units, containing approximately 20 parts per billion (ppb) total nitrobenzenes, are not likely to be a significant contributor to groundwater contamination. In addition nitrobenzenes are not accumulating in significant concentrations in the sediment or soils along the ditches. Hence, supporting evidence suggests that the existing levels of groundwater contamination at MAAP are related to activity prior to the installation of the ECWTPs in 1981.

Unfortunately, a number of off-post areas may be impacted by MAAP-derived contaminant found in the groundwater (Figure 2B). These areas include:

- Areas within the city of Milan
- An area between the post and the city of Milan
- The area of Rutherford Fork, Obion River
- Residential wells
- UT's Agricultural Station

Recent (early 1994) monthly monitoring studies by the Army have detected RDX in two of the city of Milan's public water supply wells (wells 3 and 4), but at levels below the USEPA Health Advisory level of 2 ppb. However, in early 1994, RDX concentrations exceeding the 2 ppb health advisory level were detected in one city well (well 5) and the well was shut down. These wells are located northwest of the post within the city limits. Suspected source areas are Z line, which has discharged to ditch D, and X line, which has discharged to ditch E, prior to 1981.

Regular sampling of residential wells off-post since 1982, indicate that contamination has been detected in residential wells at the Bledsoe residence and New Hope Church. Ditch D, located on-post, is the suspected source of this contamination.

The bulleted areas listed above are located near or adjacent to the off-post sites where contamination from explosive compounds has been detected. Again, the on-post drainage ditches are the suspected sources of this contamination. Over time, these compounds may have leached into the groundwater and moved off-post along the natural course of groundwater flow, which is to the north-northwest.

SECTION 3.0

TECHNOLOGY DESCRIPTION

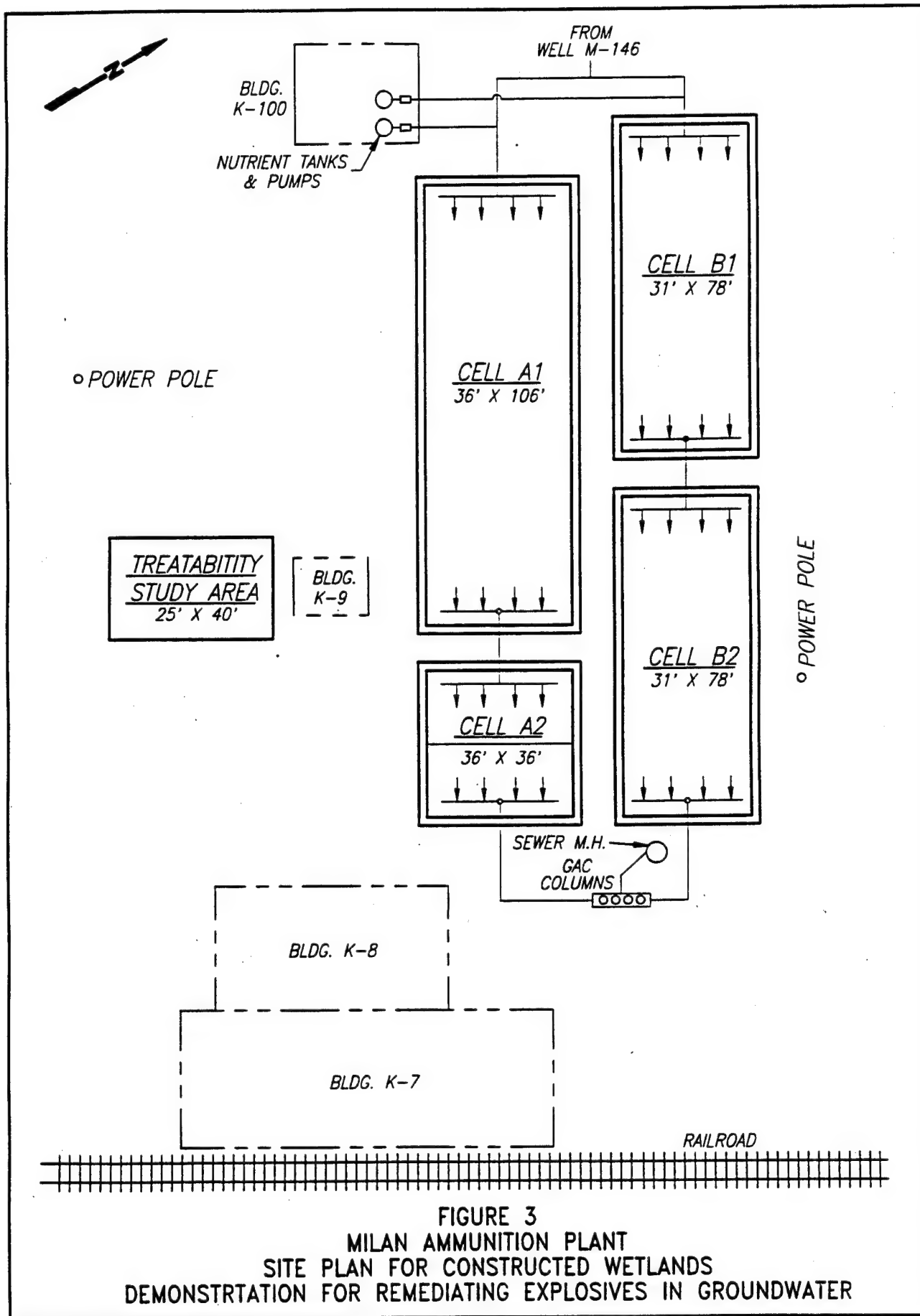
3.1 Applications

Constructed wetlands and plant lagoon systems are used for removing a broad range of contaminants from surface and groundwater sources. Degradation pathways in these systems are complex, but are generally based on the combined action of higher aquatic plants (emergent or submergent), and microbial populations composed of algae, bacteria, and fungi. Important parameters known to influence degradation pathways and kinetic degradation rates include:

- Temperature
- pH
- Dissolved oxygen concentration
- Redox potential
- Nutrient mix

3.2 Description

Two demonstration systems will be installed at MAAP. Figures 3 and 4 illustrate the conceptual layout of these systems. Demonstration A is a *subsurface flow (SSF) constructed wetland* system in which anaerobic and aerobic (reciprocating) cells are coupled in series to optimize treatment. In addition, the water level in the aerobic cells is varied (or reciprocated) to improve aerobic conditions within the aerobic cells. This is accomplished by periodically pumping water from one aerobic cell to the other. Both the anaerobic and aerobic cells will be planted with a mix of emergent wetland plant species. Demonstration B is a *Surface Flow (SF) Constructed Wetland* that consists of two lagoons, in serial arrangement, in which various submerged aquatic plants will be cultured.



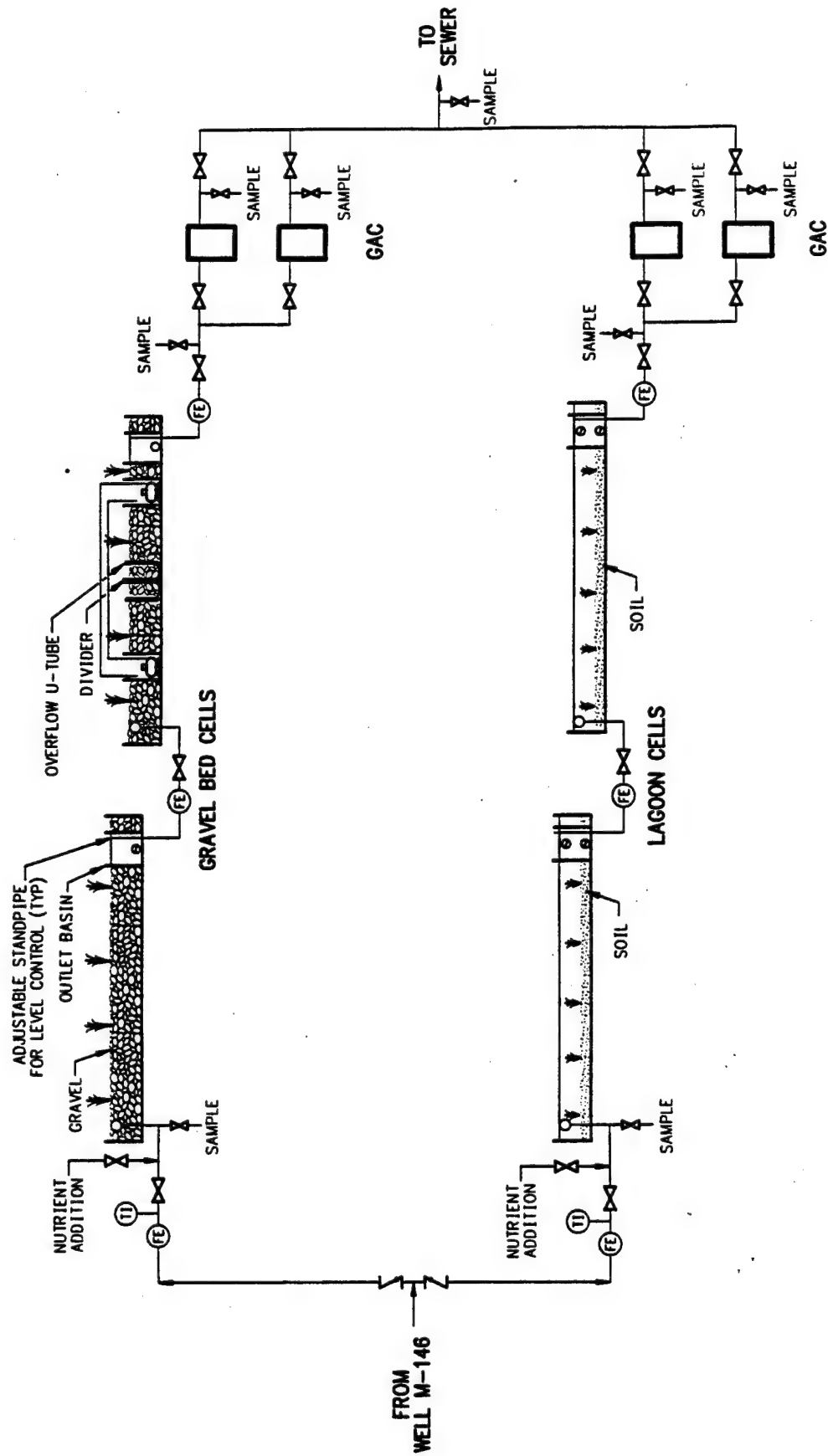


FIGURE 4
MILAN ARMY AMMUNITION PLANT
WETLANDS DEMONSTRATION

Selection of plant species for both demonstrations was based on biomass-normalized kinetic constants (k) for TNT and RDX removal. These k values were developed, and refined, for a broad range of aquatic plant species as part of the 1995 Phase I treatability studies. Plant selection for the constructed wetlands was also influenced by the plant's ability to supply carbon.

Emergent species selected for use in the constructed wetlands are canary grass (*Phalaris arundinacea*), wool grass (*Scirpus cyperinus*), and sweet flag (*Acorus calamus*). Submerged plant species selected for use are sago pond weed (*Potamogeton pectinatus*), water stargrass (*Heteranthera dubia*), and elodea (*Elodea canadensis*). Parrotfeather (*Myriophyllum aquaticum*), which can grow as both emergent and submerged, has been shown to readily degrade TNT, and will remain viable year round, will be included in both systems.

Construction of the demonstration systems will follow protocols developed by TVA in the development of their Constructed Wetlands R&D Facility (see also Steiner and Watson, 1993). Each unit (or cell) will be constructed above-ground, using insulated, standard 4 foot prefabricated poly wall panels and will be double-lined with 45 mil geosynthetic liner (EPDM). Some excavation and earth moving will be required to obtain required depths and to provide back-fill against the panels.

Design calculations are based on a total hydraulic retention time of 10 days and a minimum demonstration flow rate of 5 gal/min (19 L/min to each system). Example design calculations are provided in Table 2. These calculations show the area and depth of the individual demonstration units.

Influent and effluent manifolds will be installed on all cells. Flow meters and totalizers will be installed at the influent and effluent section of each unit to record flow data, to quantify rates of evapotranspiration, and to facilitate mass balance calculations. Sampling ports will be installed throughout each of the demonstration units to allow ease of sampling utilizing sondes

Table 2

Design Calculations for Wetland and Lagoons Systems.

SURFACE FLOW WETLAND (OR LAGOON):

This system will consist of two cells with a 10 day total/system retention time

$$(5 \text{ gal/min} \times 60 \text{ min/hr} \times 24 \text{ hrs/day} \times 10 \text{ days}) / 7.48 \text{ gal/ft}^3 = 9,625 \text{ ft}^3$$

$$\text{Assume average water depth of 2 ft.: } 9,625 \text{ ft}^3 / 2 \text{ ft} = 4,813 \text{ ft}^2$$

$$\text{Two lagoon in series: } 4,813 \text{ ft}^2 / 2 = 2,406.5 \text{ ft}^2 \text{ per lagoon with 2 ft (0.6 meter) depth}$$

For cell dimensions assuming an aspect ratio of one to 2.5 aspect ratio = 2 lagoons 31 ft x 78 ft. (9.5 x 24 meters) with 1 foot soil depth and 2 ft of water depth.

SUBSURFACE FLOW WETLAND SYSTEM:

This system will consist of:

One Anaerobic cell with 8 day retention time:

$$(5 \text{ gal/min} \times 60 \text{ min/hr} \times 24 \text{ hrs/day} \times 8 \text{ days}) / 7.48 \text{ gal/ft}^3 = 7,700 \text{ ft}^3$$

$$7,700 \text{ ft}^3 / (4.5 \text{ ft depth} \times 0.45 \text{ porosity}) = 3,802 \text{ ft}^2$$

Cell dimension assuming aspect ratio of one to three = 36 x 106 ft with 4.5 ft (1.4 meter) water depth

Aerobic Cell with 2 day retention time:

$$(5 \text{ gal/min} \times 60 \text{ min/hr} \times 24 \text{ hrs/day} \times 2 \text{ days}) / 7.48 \text{ gal/ft}^3 = 1,925 \text{ ft}^3$$

$$1,925 \text{ ft}^3 / (4.5 \text{ ft depth} \times 0.45 \text{ porosity} \times 0.75 \text{ fraction pores filled}) = 1,267 \text{ ft}^2$$

Cell dimension = 36 x 36 ft with 4.5 ft depth (11 x 11 meters with 1.4 meter depth)

and discrete samples, and to enable estimation of spatial variability (in both the horizontal and vertical).

Explosives-contaminated water will be pumped from well MI-146 directly to the influent manifolds at a flow rate of 5 gpm/system (19 L/min) and resulting in a retention time of 10 days in each system. The combined flow to both systems will be limited by the capacity of the pump at well MI-146; which, based on pump tests, is expected to deliver 16 gpm. Each system (SSF wetland or SF lagoon) will be designed for a maximum of 8 gpm (30 L/min) to provide flexibility of treating larger volumes of water if shorter retention times prove to be adequate for treatment. Each of the two water delivery systems will also be connected to independently pumped nutrient delivery systems, so prescribed amounts of nutrients can be fed into each system on demand. The pumps will be connected to timers to allow for addition of nutrients during predetermined time periods.

Water shall enter the first cell at the inlet end through a distribution header located near the top of the cell (Figure 5)--just below the surface of the gravel bed or lagoon. Flow out of the first cell will be through a collection header located near the bottom at the opposite end of the cell and into a standpipe located in the outlet sump. The outlet sump shall discharge, by gravity, into the to the inlet manifold of the second cell (Figure 6). The height of the stand pipe in the outlet sump will be adjustable and will be set at the desired water level of the first cell. Flow and level control through the second cell shall be the same as the first, with discharge from the second cell through granulated activated charcoal beds and then to the sewer.

To promote anaerobic conditions within the SSF wetland; a carbon source, milk powder, will be added to the first gravel bed every 14 days, or the retention time of the system. The amount of milk starter to be added to the SSF wetland will equal 700 mg per liter of wetland water. The milk powder will be added to the wetland via two headers placed 4 and 24 feet from the influent header. The header will contain 6 evenly spaced $\frac{1}{4}$ inch holes. Two 200 gallon vats of concentrated milk powder solutions will be made for delivery through the headers. 275 kg of milk powder will be added to each 200 gallons of potable water. Each solution will be delivered through the header at a flow rate of 0.7 gpm (2.6L/min). To ensure complete mixing

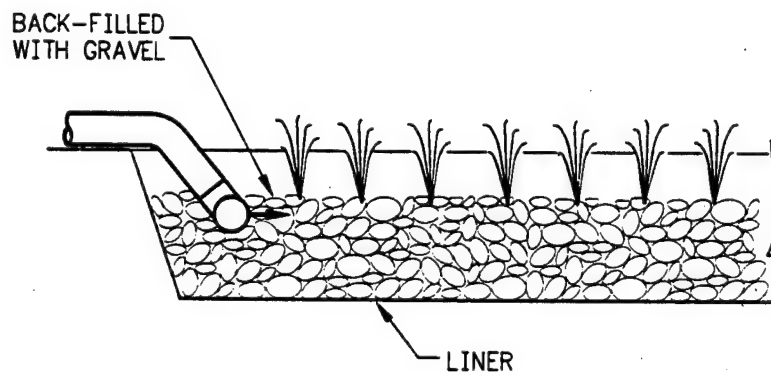
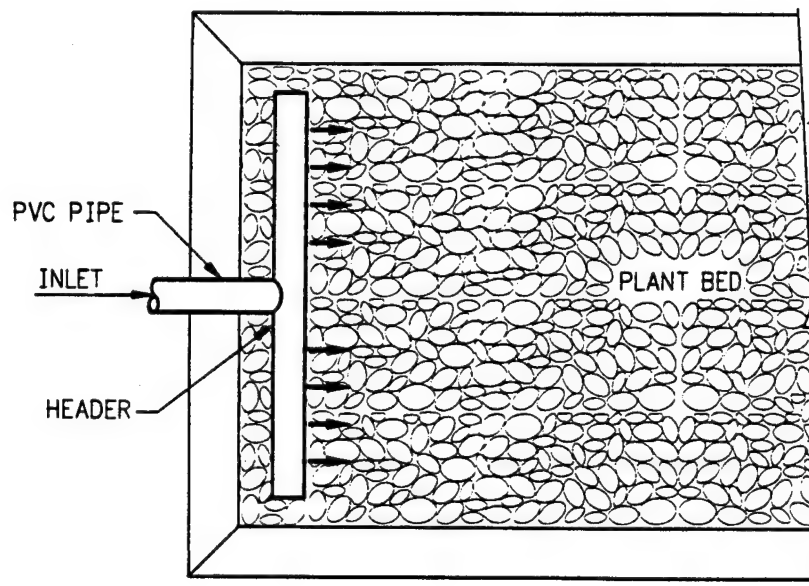
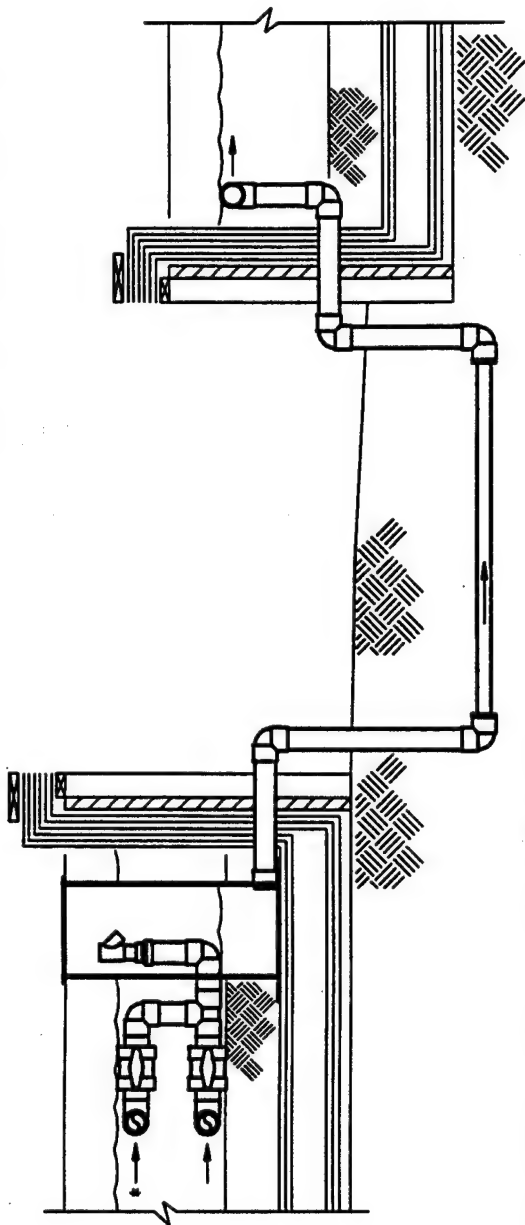


FIGURE 5
 DIAGRAM ILLUSTRATING HEADER USED FOR
 EVENLY DISTRIBUTING INFLUENT ACROSS
 THE WIDTH OF A WETLAND CELL



* The surface header is used on lagoon cells only.

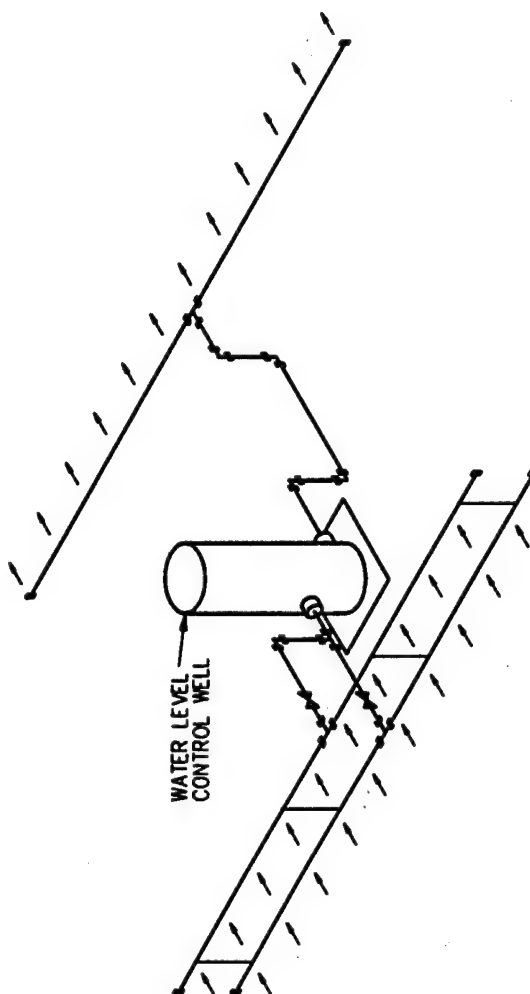


FIGURE 6
DETAILS OF WATER DELIVERY
FROM FIRST CELL TO SECOND CELL

of the milk powder with the wetland water, the water in the wetland cell will be recirculated during addition of concentrated milk powder solution. The water will be pumped from the bottom of the effluent end to the influent end near the surface at a flow rate of 150 gpm (568 L/min). The addition of milk powder and recirculation rate will occur over a set time of approximately 5 hours to ensure only one bed volume of wetland water is recirculated. Recirculating only one bed volume is considered important to make sure the concentration profile of explosives is maintained at high concentration near the influent and low concentration near the effluent.

The water level in the SSF will be set at 3 cm below the surface of the gravel beds (with 10 ½ inches or 0.2667 meters of freeboard). The lagoons will also have 10 ½ inches (0.2667 meters) of freeboard. Freeboard levels of both systems can be adjusted by the manipulating the effluent standpipes in each cell. Current freeboard levels take into consideration the maximum 100 year rainfall rate at Milan (7 ½ inches in a 24 hour period).

The anaerobic cell in the subsurface-flow (SSF) constructed wetland (cell A1, Figure 3) will initially be inoculated with commercially available forms of anaerobic bacteria used in household septic tanks. The microbial population should increase rapidly due to the available nutrient supply from fertilization with milk starter.

The aerobic cell in System A will be divided into two equal sections. Sumps will be placed in each section. Submersible pumps will be placed in each sump to allow for sequential movement (fill and drain) of water from one section to another. The pumps will be controlled by digital programmable timers (Omron Corporation). Pump rate and duration will control volume of water moved from cell to cell.

Effluent streams will leave both systems and will drain into granular activated carbon beds before discharge to the sewer. The purpose of the activated carbon beds is to reduce total nitrobenzenes to below 50 ppb. The sewer leads to the Wolf Creek Ordnance Plant Sewage Treatment Plant, having outfall 009. The sewage treatment plants total nitrobenzenes levels are

limited to 70 ppb by MAAP's NPDES permit. Thus, the total nitrobenzenes in the water entering the sewage plant will be below the NPDES permit requirement.

3.3 Advantages and Limitations

Natural-based constructed wetlands/lagoons have found acceptance as a technology for treatment of a wide variety of contaminated waters including acid mine drainage, municipal wastewater's, diesel fuels, and paper and pulp wastewater (Kadlec and Knight, 1996). The technology has appeal due to: low cost, ease of operation, and aesthetic considerations. The primary advantage of the technology is that the treatment system is passive, hence, the primary cost of the technology is incurred in building the wetland. This generally results in low overall costs. For example, when the technology is used to treat acid mine drainage the cost of constructed wetlands, about \$2 per thousand gallons, is less than half the cost of chemical treatment (\$3.75 thousand gallons). With respect to the current program, constructed wetlands are being offered as an inexpensive technology to biologically degrade explosive compounds.

The primary disadvantage of constructed wetland technology is that the degradation process is biological and thus affected by seasonal temperature fluctuations. For example, winter temperatures in the northern U.S. are known to severely limit plant and microbial growth and are expected to limit the subsequent biological degradation of explosives. However, the relationship between climatic conditions and actual biological degradation of explosives has not been thoroughly explored. Hence, the range of regional application may be larger than currently expected. As more is learned about the climatic limits of the technology, recommendations can be made on the locations in the U.S. in which constructed wetlands could successfully remediate explosive contaminated groundwater.

SECTION 4.0

TECHNICAL PERFORMANCE CRITERIA

The primary goal of the demonstration is to remediate the level of TNT down to 2 ppb and the total nitrobodyes in the contaminated groundwater to levels 50 ppb -- below the 70 ppb limit of MAAP's NPDES permit. Total nitrobodyes include TNT; RDX; HMX; 2,4 DNT; 2,6 DNT; and TNB. The approximate initial total nitrobody concentration in the contaminated groundwater is approximately 6,350 ppb. Therefore, greater than a 99% removal efficiency for total nitrobodyes is needed to successfully meet the demonstration goal.

A secondary goal of the demonstration is to produce effluent waters from the wetlands that would be acceptable for surface water discharge -- beyond the mere removal of total nitrobodyes. Since BOD, pH, and TSS are common chemical parameters for NPDES permits for surface water discharges, these parameters will be analyzed in effluent waters. The BOD is closely related to COD and organic C content of water. The COD and organic C will be analyzed throughout the wetland systems to determine effectiveness of the systems at reducing final BOD concentration in effluent waters. By-products of explosive degradation, such as 2,6 DANT and 2,4 DANT, and toxicity of effluents waters will be analyzed to evaluate whether or not effluent waters would be safe for surface water discharge.

SECTION 5.0

COST PERFORMANCE CRITERIA

Cost information for the wetlands/lagoon systems will be collected by TVA. Capital cost information to be collected will include:

- Battery limits cost of building the treatment system including:
 - Direct cost
 - Purchased equipment
 - Purchased equipment installation
 - Piping (installed)
 - Instrumentation and controls (installed)
 - Electrical (installed)
 - Indirect cost
 - Engineering and supervision
 - Construction overhead
 - Contingency
 - Contractors fee
- Time required to build treatment system
- Costs of decommissioning the treatment facility
- Time required to decommission the facility
- Offsites (examples include roads, utility equipment, buildings, fencing, lighting, etc.)
- Total plant investment
- Start-up allowance
- Cost of construction capital (also called "Escalation" or "AFUDC--Allowance for funds used during construction")
- Total depreciable investment
- Spare parts inventory
- Working capital
- Total capital investment

- Average capital investment

Operations and Maintenance cost to be collected will include:

- Direct labor
- Maintenance labor
- Supervision
- Utilities (electricity)
- Operating supplies
- Maintenance materials
- Laboratory analysis (analysis necessary for operations only)
- Plant overhead (administration, purchasing, clerical, custodial, etc.)

Where it is not possible to collect specific pieces of information, this information will be estimated.

Based on the information collected, TVA will estimate the treatment cost for the contaminated water on a \$/thousand gallon basis. This cost will include the total cost of water treatment but will not include costs associated with assessing the level of contamination at the site or collecting the water for treatment. In addition, TVA will assess economic feasibility based on cost-benefit ratio analyses of the treatment cost of wetland/lagoon systems relative to other commercially available remediation systems. These other technologies will be identified at a later date.

SECTION 6.0

SAMPLING PLAN

6.1 Overview of Sampling Operations

Both treatment systems (the constructed wetlands and plant lagoon) will be sampled with three objectives in mind:

- Assessment of treatment efficiency via routine sampling of the waters (approximately every two weeks).
- Assessment of the kinetics of explosive degradation and fate via intense sampling of the wetlands during various seasons (every 2 months).
- Routine monitoring of the surrounding environment (dissolved oxygen of water, pH temperature, redox potential, electrical conductivity, etc.).

An outline for the routine water sampling, required for assessing treatment efficiency, is provided in Table 3. This information includes analytes, sampling frequency, method, and sample position number. The samples will be taken from within the treatment system (Figure 7). Position numbers 1 through 7 refer to water samples taken from:

- The influents of the first cell of both systems (sample points 1 and 4).
- The effluents from the first cell of both systems (sample points 2 and 5).
- The effluents from second cell of both systems (sample points 3 and 6).
- The effluent discharged to sewer (sample point 7).

The explosives, explosive by-products, nutrient samples, related water flow, and environmental data (DO, pH, EC, Redox, and temperature) will be collected every 2 weeks. Total flow volumes at positions 1-6 will allow the concentration data to be evaluated in terms of loading rates and removal rates in units of mass/wetland area/time (e.g., g/m²/d). Mass of

Table 3

Routine Sampling: Outline of parameters analyzed, frequency of sampling, method of analysis, and sampling position.

Water Quality Parameters	Frequency	Method (1)	Position # (2)
TNT	Every 2 weeks	Modified 8330	1-7
RDX	Every 2 weeks	Modified 8330	1-7
TNB	Every 2 weeks	Modified 8330	1-7
HMX	Every 2 weeks	Modified 8330	1-7
2,4 DNT	Every 2 weeks	Modified 8330	1-7
2,6 DNT	Every 2 weeks	Modified 8330	1-7
2A-DNT	Every 2 weeks	Modified 8330	1-7
4A-DNT	Every 2 weeks	Modified 8330	1-7
2,6 DANT	Every 2 weeks	Modified 8330	1-7
2,4 DANT	Every 2 weeks	Modified 8330	1-7
BOD	Every 2 weeks	405.1 Series	1-7
COD	Every 2 weeks	410 Series	1-7
Total Organic Carbon (TOC)	Every 2 weeks	415 Series	1-7
NH ₄ -N	Every 2 weeks	350 Series	1-7
TKN	Every 2 weeks	351 Series	1-7
(NO ₃ +NO ₂)-N	Every 2 weeks	353 Series	1-7
(PO ₄ -P)	Every 2 weeks	365 Series	1-7
Ca, Mg, Fe, Mn, Cu, Ni, Zn, Pb, Cd	Every 2 weeks	300 Series	1-7
pH, DO, Temp, EC	Every 2 weeks	150,170, 360, and 120 Series	1-7
pH, temp., redox, DO, EC	Four measurements a day, downloaded every 2 weeks	150,170, 360, and 120 Series	8-15 at mid-depth
Suspended Solids	Every 2 weeks	160.2 Series	3 and 6
Chloride	Every 2 weeks	IC	3 and 6
Total flows	Every 2 weeks	Meter	1-6

(1) See Appendix B for details on methods and procedures.

(2) See location of sampling positions in Figure 7.

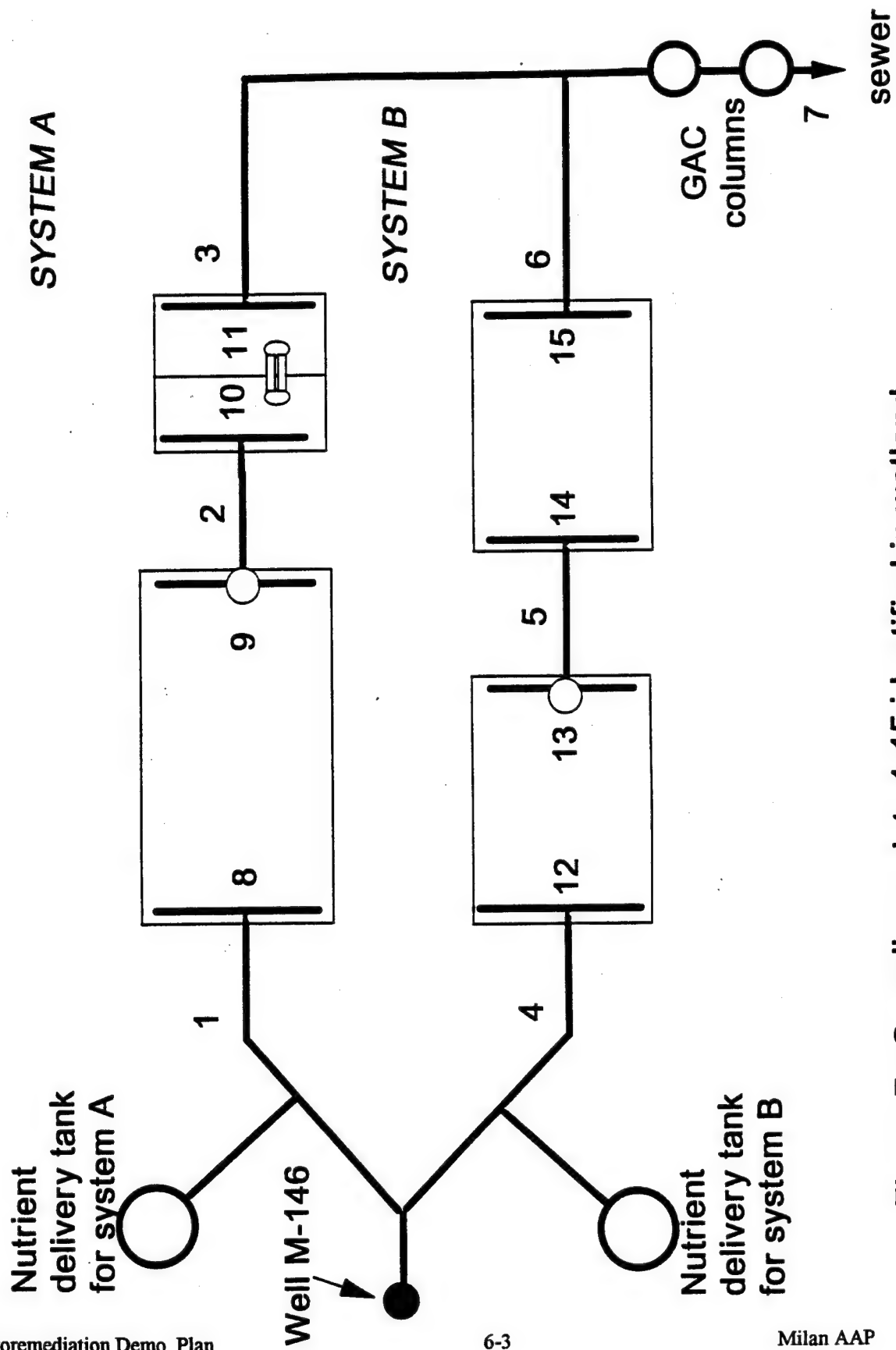


Figure 7. Sampling points 1-15 identified in wetland demonstration.

explosives can be obtained by multiplying concentration by total volume. The combination of evaporation and evapotranspiration will also be evaluated by the difference in total volume flowing into and out of each cell.

Suspended solids and chloride are additional parameters to be determined only at positions 3 and 6. Since suspended solids and chloride are likely parameters to be included in an NPDES permit for surface water discharge, these parameters are included to evaluate if the wetland effluent water quality would be suitable for surface water discharge should the technology be adopted.

To determine the treatment efficiency of the carbon beds, water samples will be taken every two weeks both before (locations 3 and 6) and after (location 7) the carbon bed treatment. If concentrations of nitrobenzenes become greater than 50 ppb at location 7, the carbon bed will be concluded to be saturated and will be replaced.

A second sampling scheme, for assessing the kinetic removal of explosives, is outlined in Table 4. This sampling will occur every 2 months and is designed to determine effects of season and wetland age on removal kinetics and fate of explosives. In this scheme, water samples will be collected from three wells placed along the width of the wetland in each quadrant shown for positions 16 to 29 (Figure 8). Full depth water samples will be composited from the three wells in each position to represent water with specific time of treatment along the length of the wetland.

Transect (cross-sectional) data collected from the quadrant positions will be used to evaluate the appropriateness of first-order kinetics to describe removal of explosives in the wetlands. First-order kinetic constants obtained from the demonstration are deemed important for future design considerations of such systems and are described in detail in the Experimental Design section.

Table 4
Intensive track sampling: Outline of parameters analyzed, frequency of
sampling, method of analysis, and sampling position.

Water Quality Parameters	Frequency	Method	Position
TNT	Every 2 mos.	Modified 8330	1-7,16-30
RDX	Every 2 mos.	Modified 8330	1-7,16-29
TNB	Every 2 mos.	Modified 8330	1-7,16-29
HMX	Every 2 mos.	Modified 8330	1-7,16-29
2,4 DNT	Every 2 mos.	Modified 8330	1-7,16-29
2,6 DNT	Every 2 mos.	Modified 8330	1-7,16-29
2A-DNT	Every 2 mos.	Modified 8330	1-7,16-29
4A-DNT	Every 2 mos.	Modified 8330	1-7,16-29
2,6 DANT	Every 2 mos.	Modified 8330	1-7,16-29
2,4 DANT	Every 2 mos.	Modified 8330	1-7,16-29
Azoxy compounds	Every 2 mos.	Modified 8330	1-7,16-29
TAT	Summer of '97 only	CE	1-7,16-29
Chemical Oxygen Demand (COD)	Every 2 mos.	410 Series	1-7,16-29
Total Organic Carbon (TOC)	Every 2 mos.	415 Series	1-7,16-29
Ammonia Nitrogen (NH ₄ -N)	Every 2 mos.	350 Series	1-7,16-29
Total Kjeldahl Nitrogen (TKN)	Every 2 mos.	351 Series	1-7,16-29
Nitrate & Nitrite Nitrogen (NO ₃ +NO ₂ -N)	Every 2 mos.	353 Series	1-7,16-29
Orthophosphate (PO ₄ -P)	Every 2 mos.	265 Series	1-7,16-29
pH (lab samples)	Every 2 mos.	150 Series	1-7, 16-29
pH, DO, Temp, EC	Every 2 mos.	150,170, 360, and 120 Series	1-7, 16-29
Toxicity test	Winter and Summer of '97	<i>Ceriodaphnia dubia</i> and <i>Pimephales promelas</i>	3,6, and Composite of 1 and 4 (Plus Two Duplicates)
Metals	Every 4 months	300 Series	1-7, 16, 19, 21, 22, 25, 26, 29
Explosives in sediments			
TNT	Every 2 mos.	Modified 8330	30-37
RDX	Every 2 mos.	Modified 8330	30-37
TNB	Every 2 mos.	Modified 8330	30-37
HMX	Every 2 mos.	Modified 8330	30-37
2,4 DNT	Every 2 mos.	Modified 8330	30-37
2,6 DNT	Every 2 mos.	Modified 8330	30-37
2A-DNT	Every 2 mos.	Modified 8330	30-37
(Table continued on next page)			

Table 4 (Continued)
**Intensive track sampling: Outline of parameters analyzed, frequency of
sampling, method of analysis, and sampling position.**

Water Quality Parameters	Frequency	Method	Position
Explosives in sediments (cont)			
4A-DNT	Every 2 mos.	Modified 8330	30-37
2,6 DANT	Every 2 mos.	Modified 8330	30-37
2,4 DANT	Every 2 mos.	Modified 8330	30-37
Azoxy compounds	Every 2 mos.	Modified 8330	30-37
TAT	Summer of '97	CE	1-7,16-29
Toxicity test	Winter and Summer of '97	<i>Hyalella azteca</i> and <i>Chironomus tentans</i>	18,21, 24,28 Plus two Duplicates
Explosives in plants			
TNT	Every 2 mos.	Modified 8330	30-37
RDX	Every 2 mos.	Modified 8330	30-37
TNB	Every 2 mos.	Modified 8330	30-37
HMX	Every 2 mos.	Modified 8330	30-37
2,4 DNT	Every 2 mos.	Modified 8330	30-37
2,6 DNT	Every 2 mos.	Modified 8330	30-37
2A-DNT	Every 2 mos.	Modified 8330	30-37
4A-DNT	Every 2 mos.	Modified 8330	30-37
2,6 DANT	Every 2 mos.	Modified 8330	30-37
2,4 DANT	Every 2 mos.	Modified 8330	30-37
Azoxy compounds	Every 2 mos.	Modified 8330	30-37
TAT	Summer of '97	CE	1-7,16-29
Hydraulic tracer analysis			
Bromide (overall mixing)	Every 4 mos.	YSI 6000 sonde	2,3,5,6
Bromide (short circuiting)	Every 8 mos.	Ion chromatograph	38-52

- (1) See Appendix B for details on methods and procedures.
(2) See location of sampling positions in Figures 7 and 8.

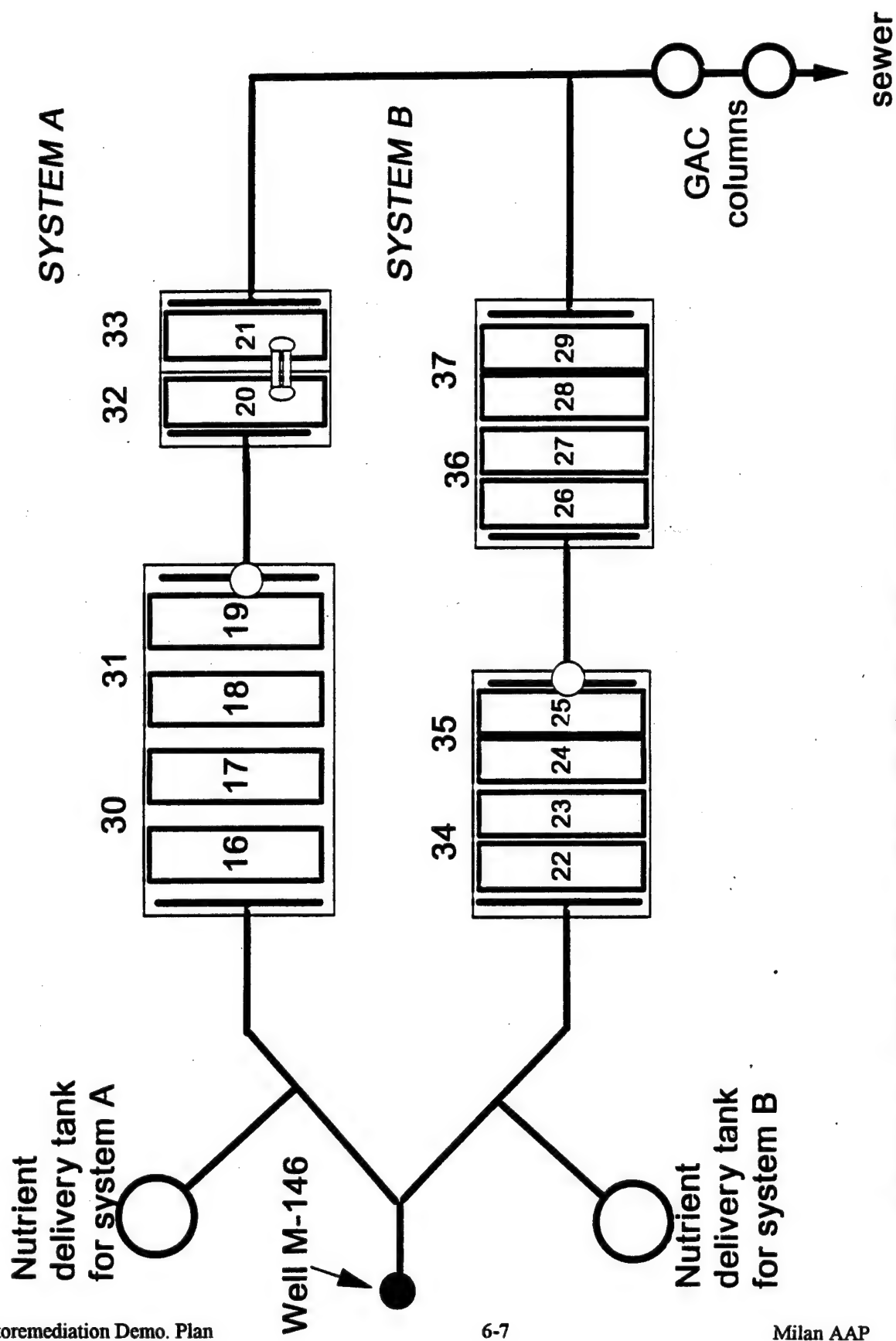


Figure 8. Sampling points 17-37 identified in wetland demonstration.

The fate of the explosives added to the demonstration wetlands will be assessed by collecting sediment, gravel, and plant samples in positions 30-37 (Figure 8) once every 2 months. Subsamples of the materials will be collected along the width of the cells and combined at the identified positions which represent areas in the first and second half of each cell. The samples will be analyzed for bound by-products or explosives, or assimilated by-products or explosives. This analysis will help determine if toxic by-products are forming in the wetland systems due to incomplete degradation.

Activities will be performed to further evaluate the potential existence of toxic compounds forming due to incomplete degradation of primary explosives. Ecological toxicity tests will be conducted on both the effluent waters and sediments as indicated in Table 4. The aquatic toxicity test will use *Ceriodaphnia dubia* (daphnia) and *Pimephales promelas* (fathead minnows) as an indicator species. Daphnia and fathead minnows are common indicator species for evaluating toxicity of aquatic phases in the environment. The sediment toxicity test will use *Hyaella azteca* and *Chironomus tentans* as an indicator species. The use of *Hyaella azteca* and *Chironomus tentans* will be used as outlined in EPA method 100.1 and 100.2 respectively. These organisms are selected as the best organism for assessing the effects of industrial effluent loads on the biological integrity of aquatic sediments. In addition to the outlined work here, it is recommended that additional work be conducted on identifying degradation by-products if sediment toxicity is observed.

Environmental information will also be collected. Weather information (rainfall, air temperature, and barometric pressure) will be obtained from Milan ammunition plant. Incident solar radiation will be collected with a LICOR Quantum sensor placed at the site. The daily condition of the wetland's water will be monitored at sample positions 8 through 15 (Figure 7), for variations in:

- Dissolved oxygen (DO)
- pH
- Temperature
- Redox potential
- Electrical conductivity (EC)

The water conditions above will be tracked through the use of monitoring sondes. The sondes will be located at mid-depth and located to quantify space- and time-related differences. Four measurements a day will be obtained and the information will be downloaded biweekly (every two weeks). Each of the programmable sondes are capable of monitoring and recording five parameters; are equipped with an independent data logger; and can be deployed for up to 30 days.

Hydraulic mixing in the wetland reactors will be assessed by using bromide as a tracer. Two types of tracer testing will occur. One type will assess the overall mixing of each wetland cell by introducing bromide at the influent and monitoring bromide concentration with an ion-selective electrode placed in a YSI 6000 Sonde in the effluent sump (positions, 2, 3, 5, and 6). Another tracer test will evaluate the existence of short circuiting by adding bromide at the influent and obtaining whole water column samples along the width of the cell near the effluent header pipe of each wetland cell (positions 38 to 52) as shown in Fig. 9. The overall mixing test will occur every four months and the short-circuiting test will occur every eight months (Table 4). Note that the design of the SSF's wetlands reciprocating cell precludes short circuiting, therefore, short circuit testing will not be performed on this cell.

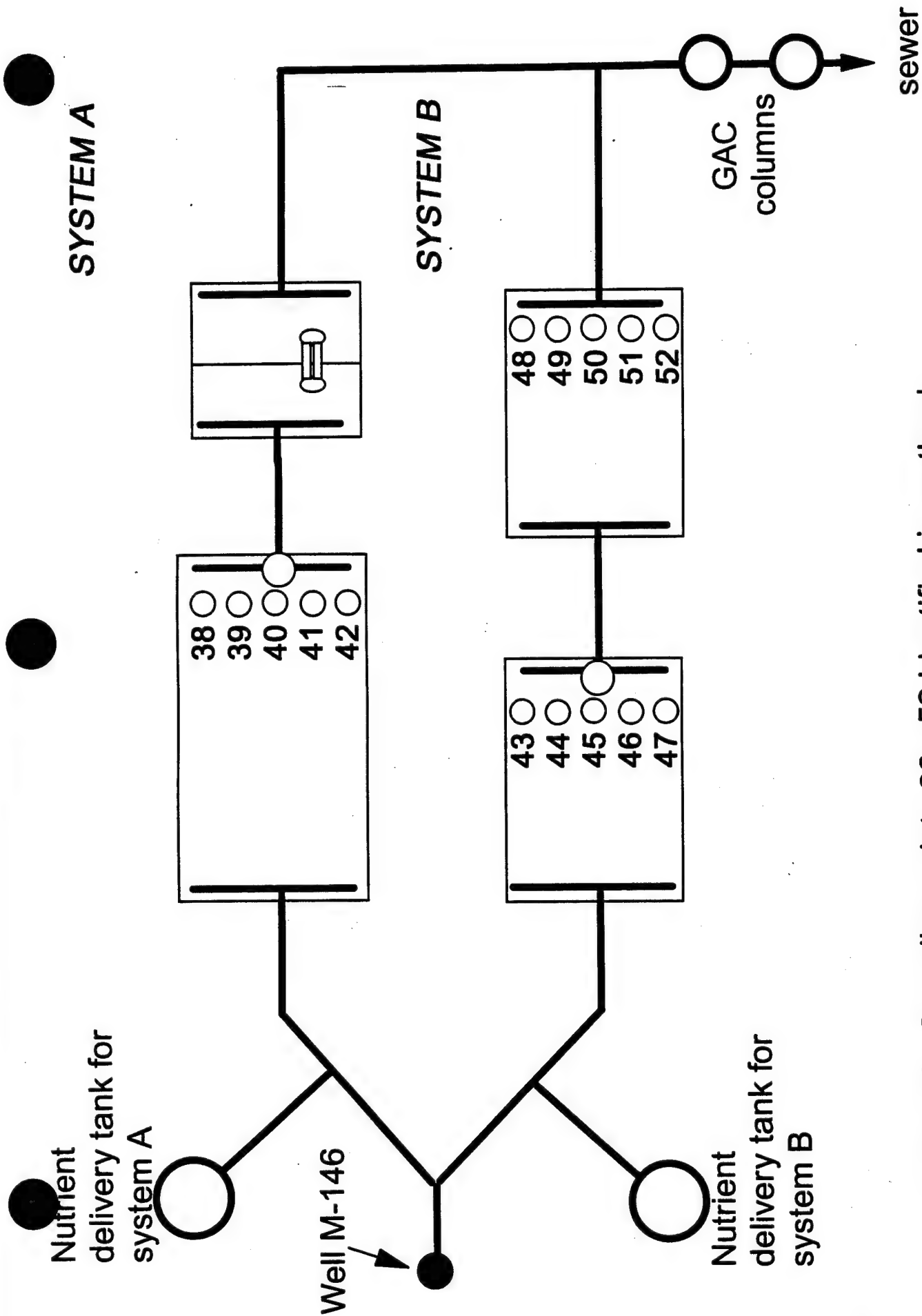


Figure 9. Sampling points 38 - 52 identified in wetland demonstration.

6.2 Sample Collection and Laboratory Procedures

6.2.1 Water, Sediment, and Plant Sampling Procedures

During routine sampling, conducted every other week, water samples will be collected from positions 1, 4, and 7 (Figure 7) by opening sampling valves placed in the PVC lines. Effluent samples will be collected from each wetland cell from a collection sump at the end of each wetland for sampling positions 2, 3, 5, and 6. The water samples in the sumps will be collected as whole water columns. Water samples collected from PVC valves or whole water column samplers will be placed into a 4 L glass beaker. Part of the solution will be transferred into a 1 L wide-mouth plastic bottle and another part will be transferred to a 60 mL amber glass bottle wrapped in aluminum foil. Both the 1 L and 60 mL collection containers will be placed in an ice chest containing ice or a commercial ice substitute and will be transported to the laboratory in the custody of a TVA employee. Samples will be refrigerated upon arrival to the lab. Water collected in glass containers will be analyzed for explosives and degradation products. Water collected in the 1 L plastic container will be analyzed for other water quality parameters as outlined in Table 3.

The pH, DO, temperature, and EC of the water being collected and sent to the lab will be determined in excess water collected in the 4 L glass beaker after transferring enough water into 1 L and 60 mL amber bottles for laboratory analyses for positions 1, 4, and 7. A YSI sonde probe will be placed in the beaker, submerging all probes below the water level. For positions 2, 3, 5, and 6, a YSI sonde probe will be placed into the effluent collection sumps at mid-water depth. The pH, DO, temperature, and EC will be monitored and recorded on a data collection sheet in the field.

During the sampling periods that will occur once every 2 months, water samples will be collected from positions 1-7 in the same fashion as described above. For positions 16-29, (Figure 8) water will be taken from slotted PVC pipes placed vertically in the wetlands during construction. Water will be sampled with a water column sampler. Three PVC pipes will be placed in each sampling quadrant equally spaced across the width of the cells. A whole water

column sample will be taken from each of the three PVC pipes within each quadrant and composited to represent one water sample from a specific distance between the influent and effluent headers. The whole water column samples collected will be placed in a 2 L beaker. When all three wells have been sampled within a specific quadrant, a 50 mL sub-sample will be placed in a 60 mL amber glass container (glass wrapped in aluminum foil) and a 1 L sample will be placed in a 1 L plastic wide-mouth bottle. The samples will immediately be placed in an ice chest containing ice or a commercial ice substitute and will be transported to the laboratory in the custody of a TVA employee. All samples will be refrigerated upon arrival in the lab. All samples received from the test site shall be handled in accordance with TVA's chain of Custody procedures (see section 6.2.4). The sample containers will be labeled to identify date collected, location, and project identification. A YSI sonde probe will be used to determine pH, DO, temperature, and EC by placing the probe at a shallow and deep depth within each PVC well in positions 16-29 after collected water samples. The measured parameters will be recorded on a data collection sheet.

Access to the sampling wells in the gravel beds will occur by walking on top of the gravel. In the lagoon wetlands, a small flat bottom boat will be used to gain access to the sampling wells.

During intensive track sampling, sediment and plant samples will be taken in the front and back half of each wetland cell at locations 30 to 37 (Figure 8). In the gravel bed wetlands, sediment will consist of gravel placed into the system. The gravel will be collected from the surface to mid depth with a shovel. Gravel will be collected from three locations within each half section of each cell. Collected gravel will be homogenized in a large bucket. A sub-sample will be placed in a 4 L wide-mouth brown plastic container, the container will be wrapped with aluminum foil, and placed in an ice chest containing ice or a commercial ice substitute. A plastic container will be used to avoid breakage. Adsorption of explosives onto the plastic container via diffusion of explosives within the gravel to the interior plastic surface will be assumed minimal. Sediment will be collected from the lagoon systems with a submerged sediment probe. The probe will be used to collect sediment from ten locations within each half section of each cell. The locations will be accessed with a flat bottom boat. The sediments in each cell half section will be homogenized and stored in a 1 L wide-mouth

brown glass container, the container will be wrapped in aluminum foil, and stored in an ice chest containing ice or a commercial ice substitute. Sediments will be labeled to identify date of collection, location, and project identification. Upon receipt at the laboratory, sediments will be kept refrigerated until analysis of contents via acetonitrile extraction (modified method 8330). All samples received from the test site shall be handled in accordance with TVA's chain of custody procedures (see section 6.2.4). Analysis of explosive content in the sediment will be normalized to dry matter weight of sediment by determining moisture content.

For toxicity testing of water and sediments, water and sediment samples will be collected from each location and stored in a separate container. The sample will be shipped to the TVA toxicity lab. Toxicity analysis will be conducted on water using *Ceriodaphnia dubia* and *Pimephales promelas*; sediments will be analyzed using *Hyaella azteca* and *Chironomus tentans*. Examples of the approach used by TVA to assess toxicity are provided in Appendix C in the form of final reports from three previous tests. These reports provide the details of the procedures used by TVA to conduct toxicity tests.

Plant samples will also be collected from each half of the wetland cell during intensive track sampling. A representative sample will be collected for each species in each sampling location. A flat bottom boat will be used to access plants in the lagoon system. The sample will be weighed immediately after harvesting with a balance in the field to obtain wet weight. Each sample will be placed in large plastic bags identifying the sample according to plant species, date collected, location collected, and project description. A subsample will be placed in a ziploc plastic bag, stored in ice, and properly identified. The subsample will be frozen once it arrives at the lab and will be saved for nitrobody analysis. The samples stored in large plastic bags will be taken to the TVA constructed wetlands facility and placed in a forced-air oven to dry the plant materials at 60° C. After drying, the plant materials will be weighed for dry weight and ground to pass a 60 mesh screen for subsequent nutrient analysis. The ground plant materials will be stored in glass containers and labeled according to plant species, date sample collected, location collected, and project description.

All samples received from the test site shall be handled in accordance with TVA's chain of custody procedures (see section 6.2.4).

6.2.2 Sampling Procedures for Hydraulic Tracer Testing

The following tasks will be performed only if funding is available.

During the tracer tests, bromide will be added as KBr to each wetland cell through the influent header. A tracer test on overall mixing will first be conducted on the second cell of each wetland series. Potassium bromide will be added as a concentrated solution to the effluent sump in the first wetland cell of each series. An YSI 6000 sonde equipped with a Br ion-selective electrode will be installed in the effluent sump of the second cells to monitor Br as it leaves the second cell. The sonde will be programmed to monitor Br every 30 minutes. In addition to monitoring Br concentration in the effluent, volume of effluent water leaving the cells will be recorded from the effluent flow meter every 30 minutes. Monitoring both Br concentration and water volume will allow for determination of total Br mass leaving the wetland. Bromide mass leaving the wetland should equal mass introduced into the wetland for accurate analysis of hydraulic mixing. One week after the tracer test on the second cell of each wetland series, the tracer test will be performed on the first cell of each series. Bromide will be introduced into the influent header via the chemical delivery system and Br will be monitored in the effluent sump of the first wetland cells every 30 minutes via the YSI 6000 sonde. Flows out of the first wetland cells will also be monitored and recorded.

A second tracer test will test the existence of short circuiting occurring in the cells and will consist of monitoring Br in 5 wells placed close to the effluent header of each wetland cell. Bromide will be added to the influent of each wetland as describe for the overall mixing tracer test. The difference with the short-circuiting test is that whole water column samples will be taken from each of the 5 wells and analyzed for Br concentration in the laboratory via ion chromatography. The test for short-circuiting will coincide with the tracer test on overall mixing.

6.2.3 Field Data Collection Procedures

The water quality field data collected will include pH, DO, temperature, EC, and redox. The data will be collected with YSI 600 and YSI 6000 probes. The YSI 600 sonde will be used to take one measurement of pH, DO, temperature, and EC in water samples taken during each sampling event. The YSI 6000 sonde will be used to obtain daily cycles of pH, DO, temperature, EC, and redox by measuring these parameters every 6 hours.

Before being taken to the field, both the YSI 600 and YSI 6000 sondes will be standardized according to the procedures outlined by the manufacturer of the probes (Appendices B-3 and B-4). The hand-held YSI 600 will be standardized in the lab before each trip to the field to measure pH, DO, temperature, and EC. The YSI 6000 sondes will be removed from locations 8-15 and brought to building K-9 to allow for downloading of the measured data onto a laptop computer. The downloading procedure is outlined in Appendix B-4. After downloading 2 weeks of data, the sondes will be recalibrated according to manufacturer specification's (Appendices B -3 and B-4) in building K9.

6.2.4 Laboratory Procedures

Standard operating analytical procedures for data collected in the laboratory, including those for determining the explosive content of sediment and plants samples, is provided in Appendices B-1 through B-15.

6.2.5 Sample Storage, Packaging, and Shipping

All samples received from the test site shall be handled in accordance with ALEA procedure SP-0001, "Sample Chain of Custody" (Appendix B-15).

After sampling, samples shall be refrigerated or stored on ice or a commercial substitute until shipment. Samples shall be shipped on ice or a commercial substitute. Samples shall be refrigerated upon receipt.

No attempt shall be made to store samples or sample extracts beyond that period of time required for initial assessment and review of laboratory data.

6.2.6 Blanks

Field quality control samples shall consist of at least one blank and one sample (where the sample media permits) each group of twenty field samples or subset thereof.

6.3 Sampling Equipment

The equipment used for collecting field and laboratory data is outlined in Table 5.

Dissolved oxygen, pH, electrical conductivity (EC), temperature, and redox will be determined in the field with hand-held instruments. Several types of hand-held instruments are available for this type of data collection, Table 5. For discrete analysis in time, the YSI 600 sonde will be the most convenient since it measures DO, pH, EC, and temperature in one probe. The other single analyte instruments are available and may be used if needed.

The YSI 6000 sondes will be used for taking continuous measurements of water quality. The TVA Constructed Wetlands Program has twenty YSI 6000 monitoring sondes which are capable of monitoring and recording five parameters including DO, pH, temperature, redox potential, and conductivity. Each sonde is programmable and is equipped with an independent data logger with battery pack and thus can be deployed for up to 30 days. These sondes will be used to provide water quality information and will be placed at different locations within the demonstration cells to correlate effects from spatial and temporal differences in diurnal cycles. Other environmental information on inputs, such as rainfall, air temperature, and barometric pressure, should be available from UT's Jackson Agriculture Experiment Station.

Table 5
Equipment Used for Data Collection

Field Data	Equipment
DO, pH, EC, Temperature	YSI 600 Sonde
DO	YSI 600 Sonde
pH	Orion
EC	Orion
DO, pH, EC, Temperature, Redox	YSI 6000 Sonde
Laboratory Data	
Explosives and related byproducts	Varian HPLC
Azoxy compounds	Hewlett Packard Capillary Electrophoresis System
TKN, NH ₄ , NO ₃ , and PO ₄	Lachat Quick Chem 8000 or Technicon AutoAnalyzer II
Organic C	Dohrmann DC 190
BOD	Incubation and YSI DO probe
COD	Hach DR/3000
Metals	Perkin Elmer or Thermo Jarrel Ash ICP
pH	Orion meter

Explosive and explosives by-product content will be determined in water and sediments collected from the field via a high pressure liquid chromatograph. Total Kjeldahl Nitrogen (TKN), $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, and $\text{PO}_4\text{-P}$ will be determined colorimetrically via an automatic analyzer. Chemical oxygen demand will be determined by a colorimetric analysis. Metals will be determined by inductively coupled plasma (ICP) spectrophotometry. Bromide analysis in the field will occur with an ion-selective electrode placed in a YSI 6000 sonde. Bromide analyses in the laboratory will occur via ion chromatography. The pH of water samples taken to the laboratory will be analyzed with a glass electrode and pH meter. (All procedures are referenced in Appendices B-1 through B-14)

6.4 Sampling Documentation

Field sampling logs will be produced and completed at the time of sampling to ensure dates, times, locations, volumes, flows, and other pertinent data and conditions are recorded. Sample identification numbers will be written on both the sample bottle and sample log sheet for easy identification and cross referencing. Sample identification codes or numbers will be assigned in a logical manner to ensure ease in correlating between codes and sampling locations. Calibration records will be kept either in the field sampling log or in another location. Field sampling logs will be signed by the person taking the samples.

Examples of sample identification numbers to be used are shown in Table 6 for the group of water samples taken biweekly and bimonthly. For this study, biweekly is defined as once every other week and bimonthly is defined as once every other month. The first number of the sampling scheme is the numeric order of the sample taken, the second identification letter refers to the frequency group of sample taken (BW for biweekly, BM for bimonthly, and BR for bromide tracer analysis every four to eight months), the third identification letter refers to sample type (AQ for water, SD for sediment, or PL for plant), the fourth identification number refers to location of samples (as outlined in Figures 7 to 9), the fifth identifier is the date of sample collection, and the final identifier is the initial of the field person in charge of the sampling. The total number of samples taken in each group is the highest number of the first identifier. For

Table 6.
Sample Identification for Collected Water Samples.

Biweekly	Bimonthly
1.BW.AQ.1.4/1/96.FJS	1.BW.AQ.1.5/1/96.FJS
2.BW.AQ.2.4/1/96.FJS	2.BW.AQ.2.5/1/96.FJS
3.BW.AQ.3.4/1/96.FJS	3.BW.AQ.3.5/1/96.FJS
4.BW.AQ.4.4/1/96.FJS	4.BW.AQ.4.5/1/96.FJS
5.BW.AQ.5.4/1/96.FJS	5.BW.AQ.5.5/1/96.FJS
6.BW.AQ.6.4/1/96.FJS	6.BW.AQ.6.5/1/96.FJS
7.BW.AQ.7.4/1/96.FJS	7.BW.AQ.7.5/1/96.FJS
	8.BM.AQ.16.5/1/96.FJS
	9.BM.AQ.17.5/1/96.FJS
	10.BM.AQ.18.5/1/96.FJS
	11.BM.AQ.19.5/1/96.FJS
	12.BM.AQ.20.5/1/96.FJS
	13.BM.AQ.21.5/1/96.FJS
	14.BM.AQ.22.5/1/96.FJS
	15.BM.AQ.23.5/1/96.FJS
	16.BM.AQ.24.5/1/96.FJS
	17.BM.AQ.25.5/1/96.FJS
	18.BM.AQ.26.5/1/96.FJS
	19.BM.AQ.27.5/1/96.FJS
	20.BM.AQ.28.5/1/96.FJS
	21.BM.AQ.29.5/1/96.FJS

water samples collected for bromide analyses in the laboratory, an additional identifier will be included after the date that identifies the time the sample was taken. Plant and sediment samples will be identified in a fashion similar to that shown for water samples in Table 6 except that SD or PL will be used rather than AQ.

SECTION 7.0

EXPERIMENTAL DESIGN

The objective of the field demonstration program is to evaluate the effectiveness of using constructed wetlands for remediating groundwater contaminated with various explosives and to obtain sufficient information to transfer the technology to other locations. The treatments in the demonstration will be the two types of wetlands (subsurface- and surface-flow). Parameters that can be modified in the systems are flow rate into the wetlands, nutrient input levels injected into the wetlands, water level, and rate of reciprocating water in the aerobic gravel bed. Current plans are to set the parameters at predetermined levels and maintain them throughout the demonstration that will last from April 1996 to July 1997. However, flexibility still exists to make decisions during the course of the study to alter these adjustable parameters.

The demonstration will be conducted from April 1996 to July 1997. The groundwater to be treated contains approximately 0.178 mg/L HMX, 2.98 mg/L RDX, 0.15 mg/L TNB, 1.99 mg/L TNT, and 0.026 mg/L DNT (see section 1.4). Once every two weeks, samples will be collected for analysis of explosive and explosive by-product concentrations in the influent and effluent waters in each wetland cell. General trends in the concentrations with time will be analyzed and compared in both treatment systems. Because there may be different evaporation and transpiration rates in both systems, which would affect concentrations, explosive removal rates will be determined as:

$$\text{Removal rate (mg/m}^2\text{/d)} = [(\text{flow rate into each system (L/d)} \times (\text{influent concentration (mg/L)}) - (\text{flow rate out of each system (L/d)} \times (\text{effluent concentration (mg/L)}))] / (\text{wetland area (m}^2\text{)})$$

As with concentrations, the removal rates between the two treatments will be analyzed for their seasonal trend with time as well as compared to one another.

Removal rates will be plotted against loading rates into each wetland cell. The loading rate will be calculated as:

$$\text{Loading rate (mg/m}^2\text{/d)} = [(\text{flow rate into each system (L/d)} \times (\text{influent concentration (mg/L)})] / (\text{wetland area (m}^2\text{)}).$$

A plot of removal rates vs loading rate is useful to assess the range of loading rates that can be effectively treated by wetlands. The efficiency of explosive compound removal will be determined by how closely the data fits a 1:1 line in a plot of removal rate vs loading rate which represents 100% removal efficiency.

The influent and effluent data from each wetland cell will be used to calculate first-order rate constants assuming plug flow hydraulics. The first-order equation for plug flow hydraulic assumption for wetlands can be shown as (Kadlec and Knight, 1995):

$$\ln [(C_o - C^*) / (C_i - C^*)] = -y (k/q) \quad [\text{Eq. 1}]$$

where C_o is the outlet concentration of pollutant from a wetland, C_i is the inlet concentration of pollutant, C^* is a background level of pollutant, k is the first-order rate constant with units of m/yr , q is hydraulic loading rate in units of m/yr , and y is the fraction of distance from inlet to outlet. When evaluating concentrations in the inlet and outlet, as Eq. [1] does, y equals 1. If the background level of explosives in wetlands is assumed to be zero, rearranging Eq. [1] yields:

$$k = -q \ln (C_o/C_i) \quad [\text{Eq. 2}]$$

First-order rate constants will be determined from each set of inlet and outlet concentrations from each wetland cell using Eq. [2]. The dependency of k with time will be evaluated with regression analyses.

The first-order rate constants determined from Eq. [2] will be validated with transect samples collected during intensive sampling. The concentration in the transect samples would take the place of C_o in Eq. [2] and y would be the fraction of distance from inlet to outlet.

$$\ln (C/C_i) = -y (k/q) \quad [\text{Eq. 3}]$$

Rearranging Eq. [3] yields:

$$C = \exp (\ln (C_i) - y (k/q)) \quad [\text{Eq. 4}]$$

A plot of C vs y will be constructed using the k value determined from inlet and outlet data from Eq. [2] and average C_i and q values. The plot of Eq. [4] would be expected concentrations along the length of the wetland assuming plug-flow hydraulics and first-order removal of explosives. The actual concentrations from the transect data will be plotted with the calculated concentrations from Eq. [4] to validate the use of the first-order rate constant in Eq. [2] to describe the removal of explosives in wetlands. The determination of k values from Eq. [2] and subsequent validation of the k values with transect data has been successfully conducted for several wetlands with regards to suspended solids, BOD, NH_4 , and PO_4 removal (Kadlec and Knight, 1995).

The first-order rate constants determined from Eq. [2] assumes the existence of a first-order plug-flow reactor. First-order kinetics in a plug-flow reactor is often assumed for constructed wetlands for wastewater treatment. However, constructed wetlands rarely exhibit plug-flow hydraulics. Rather they often emulate a reactor in between plug flow and continuous stirred tank reactor (CSTR). Use of plug-flow kinetic constants from existing constructed wetlands to newly designed wetlands is adequate if the degree of mixing in the newly designed wetland has mixing characteristics equal to or less than the constructed wetland in which the plug-flow kinetic constant was obtained. However, if the new wetland has better mixing than the existing wetland, use of the kinetic constant can result in underdesigning the new wetland for a specific level of pollutant in the effluent. To adequately transfer the correct rate constants for explosives removal from the demonstration to other sites, the level of mixing in the demonstration wetlands will be assessed with tracers.

With tracer testing, the number of CSTRs a wetland emulates can be obtained by plotting the fractional mass of tracer leaving the wetland ($f(t)$) vs time (t). The continuous function can be shown to be:

$$f(t) = N / (N-1)! (N t/NRT)^{N-1} \exp(-N t/NRT) \quad [\text{Eq. 5}]$$

where N is the number of CSTRs, t is time, and NRT is nominal retention time. The nominal retention time is the volume of wetland water divided by inlet flow. Equation 5 can be plotted with various N values to determine which N value results in the best fit of the calculated function to actual tracer data. The best mixed reactor is 1 CSTR (N=1). An infinite number of CSTR reactors becomes a plug flow reactor (N = infinity). Many surface flow wetlands can be modeled to 3 CSTR reactors regardless of length to width ratios (Kadlec and Knight, 1995). For subsurface flow, a mixture of PFR and a combination of CSTR reactors is often needed to model hydraulic flow.

Once the hydraulic flow through the wetland cell is identified, a unitless Damkohler number can be calculated from:

$$C_o/C_i = 1 / [1 + Da / N]^N \quad [\text{Eq. 6}]$$

where N is the number of CSTR reactors and Da is the Damkohler number. The Damkohler number is equal to k/q , where k is the first-order rate constant and q is the hydraulic loading rate. Using outlet (C_o) and inlet (C_i) concentrations of explosives and the number of CSTR reactors identified in the tracer test, Da can be calculated from Eq. [6]. The Da constant can then be used to calculate an intrinsic rate constants as:

$$k_{int} = Da (demo) q \quad [\text{Eq. 7}]$$

This intrinsic first-order rate constant is a better reflection of removal rate of explosives since the actual mixing characteristics of the wetland is taken into account with Da. The k_{int} can be used to design other wetlands without making assumptions on the degree of mixing of the demonstration wetland and any newly designed wetland. The first-order plug-flow constants will still be calculated and deemed important since they are the most common constants considered in wetlands treatment and are easily calculated from influent and effluent data. The first-order plug-flow constants will be compared to the first-order intrinsic constants that take into account the degree of mixing in the wetland.

Short circuiting of water through the wetland can be evaluated from the tracer detention time determined from the residence time distribution function in Eq. [5]. If the tracer detention

time is much less than the nominal retention time, severe short-circuiting may have occurred in the wetland. A separate tracer test will be conducted to further evaluate short-circuiting by placing 5 wells across the width of each wetland near the effluent header. Bromide tracer will be added to the influent and whole water column samples will be taken in the 5 wells near the effluent with time. Bromide concentrations will be plotted vs time in each of the 5 wells to determine if there is preferential flow occurring in the wetlands.

The water concentrations of explosives and related by-products are the most critical data to successfully achieve the objective of the demonstration. Supplementary data on water chemistry, such as nutrient levels, DO, temperature, redox, EC, and pH, will be correlated with removal rate constants and explosive/by-product concentrations to evaluate the cause for greater or lesser explosive/by-product removal in a given wetland system with time. Extraction of sediment and plant samples for explosive/by-products concentrations will be used to evaluate fate of explosives in wetland systems.

SECTION 8.0

QUALITY ASSURANCE PLAN

8.1 Purpose and Scope of the Plan

The purpose of the quality assurance plan is ensure that:

- Sufficient measurements are made to assess the effectiveness of the proposed treatment methods
- Samples taken are representative of the conditions in the experimental setup
- Samples are delivered to the laboratory for analysis without deterioration
- Measurement techniques are sufficiently specific to measure the target compounds
- Data taken are reliable

The quality assurance plan applies to all activities including the operation of the demonstration facilities, sampling, and laboratory analysis of samples.

8.2 Quality Assurance Responsibilities

The attached organizational chart, Figure 10, shows the TVA organizations providing support to the project. Responsibilities of staff members area as follows:

- The Project Manager provides overall direction for the project and ensures staffing is adequate to meet project goals and schedules.

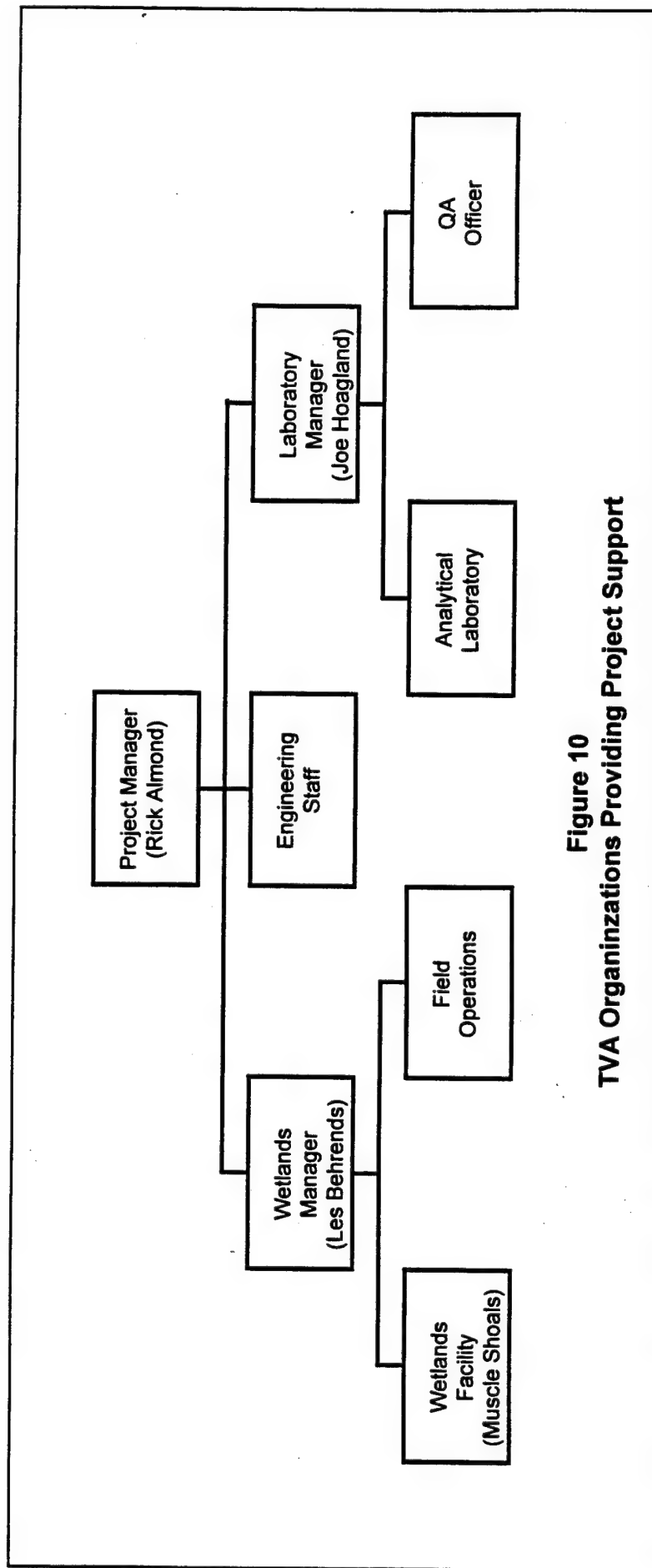


Figure 10
TVA Organizations Providing Project Support

- The engineering staff reports to the project manager and is responsible for performing detailed design engineering and construction, producing the final data evaluation, and reporting on project activities.
- The Wetlands Manager reports to the Project Manager and is responsible for providing technical direction and staff for development of processes and experimental design. He also provides oversight of field operations.
- Wetlands Facility staff (Muscle Shoals) reports to the Wetlands Manager and is responsible for designing field experiments and bench scale tests. The staff also provides technical expertise in design, operation, and assessment of the field test facility.
- Field Operation Team (Milan) reports to the Wetlands Manager and is responsible for the operation of test facilities and documentation of experiments. The team provides for calibration and operation of test equipment. The team performs field sampling, packages samples for shipment to the analytical laboratory, and documents sampling activities.
- The Laboratory Manager reports to the Project Manager and is responsible for providing project analytical oversight and for final data integrity. The Laboratory Manager is also responsible for providing monthly project reports to the Project Manager.
- The Quality Assurance Officer of ALEA reports to the Laboratory Manager and has no direct responsibilities in testing or analysis of the samples. The QA Officer is responsible for auditing actions and documentation to ensure adherence to this Plan. The QA Officer is responsible for providing quarterly quality control data reports to the laboratory manager.
- Research chemists and research scientists report to the Laboratory Manager and are responsible for planning, design, testing, and documentation of the various sub-projects assigned to them. They are responsible for producing periodic progress reports to the laboratory manager. They are responsible for review of data falling under their areas of responsibility.

- Chemical laboratory analysts and technicians report to the Laboratory Manager and are responsible for following procedures and instructions to provide analytical measurements required in the course of the project. They are responsible for review of the data they produce, documentation of analytical runs, and equipment maintenance.

8.3 Data Quality Parameters

8.3.1 Accuracy

Percent recovery, standard deviation, and other commonly used statistical indicators of accuracy are to be calculated as defined in Chapter 1 of SW-846, 3rd Edition.

8.3.2 Precision

Relative percent difference, standard deviation, and other commonly used statistical indicators of precision are to be calculated as defined in Chapter 1 of SW-846, 3rd Edition.

8.3.3 Method Detection Limit, Method, Quantitation Limit

Method Detection Limits shall be calculated as defined in Title 40, Code of Federal Regulations, Part 136, Appendix A, "Definition and Procedure for the Determination of the Method Detection Limit" - Revision 1.11.

Method Quantitation Limits are defined as five times the Method Detection Limit as in Chapter 1 of SW-846, 3rd Edition or as the lowest point used in making the calibration curve, whichever is higher.

8.4 Calibration Procedures, Quality Control Checks, and Corrective Action

The precision and accuracy of analytical procedures will be demonstrated before they are used for analysis of samples. Any modifications to approved methods will be documented in a written modification of the procedure. Any modifications found to be necessary will be reviewed, approved, and promulgated to those performing the work as written procedures in

accordance with ALEA Procedure GLP-0001 "Laboratory Procedure Preparation" and GLP-0003, "Procedure Preparation and Distribution."

Under the requirements of Chapters 1 and 4 of SW-846 and the further specific requirements of Method 8330, a variety of quality control samples shall be run as specified below when analyzing by HPLC, CE, IC, or FIA.

8.4.1 Initial Calibration Procedures

8.4.1.1 Laboratory Instrumentation

The calibration frequencies and tests required in Method 8330 and Method 8000A (as referenced by Method 8330) shall be the guidelines for calibration of the equipment used in the HPLC ,CE, IC, and FIA methods.

8.4.1.2 Setup QC

General

ALEA must demonstrate that all glassware and reagents are free of interferences by running blank samples. Blanks should include acetonitrile, water, methanol, buffers or any other solvents used in the process.

ALEA must run an initial QC check sample set of known concentration to ensure method precision and accuracy are defined.

Retention time windows must be established (not applicable to FIA).

Each analyst must demonstrate the ability of generate acceptable results with the methods by utilizing proficiency samples or standard reference material.

Method Detection Limits

ALEA must determine method detection limits for each target compound.

Retention Time Windows

For HPLC analysis, three injections are made of each analyte during a 72-hour period and retention times are determined. Their means and standard deviations are calculated. Plus or minus three standard deviations from the mean value is to be used as the retention time window for each analyte. Reference section 7.5 of Method 8000A. When a new column is installed, retention time windows must be determined. Some commercial peak-identification software only allow one window per set of analytes. In this case, the largest window shall be utilized.

Retention times are more variable for CE. Quality requirements are not yet known for this technique.

For IC, retention time windows will be set according to manufacturer's recommendation.

Method Accuracy and Precision

A quality control check sample (laboratory control sample) containing each analyte of interest but made independently from the calibration standards shall be run four times. The average recovery and its standard deviation shall be calculated for each analyte. The recovery should fall between 90 and 110%. The relative standard deviation should be 10% or less.

Any analyte which falls outside limits shall be analyzed again in a similar manner after problems are resolved. (Reference section 8.6 of Method 8000A.)

8.4.1.3 Field Instrumentation

Field instrumentation (pH, conductivity, dissolved oxygen, and redox potential) shall be calibrated according to manufacture's instructions. Specifically, pH meters shall be calibrated with two commercially purchased buffer solutions which bracket the expected range of measurements.

8.4.2 Continuing Calibration Procedures

8.4.2.1 Method 8000A/8330 Calibration QC

Reference Method 8000A Section 7.4 and Method 8330 Section 7.3

For HPLC, calibration will be performed in triplicate with standards of five concentrations over the range of interest or range of linear response of the device. The lowest concentration should be approximately equal to the method detection limit.

For HPLC, at the beginning of each day, the midpoint calibration standard will be analyzed in triplicate. The response factor for the average of these three points must be within 15% of the response factor for the initial calibration. If not, the machine will be recalibrated. Then at least every ten samples and at the end of the run, a single midpoint calibration standard will be run. The response factors for these must be within 15% of the mean daily initial response factor. Those groups of ten samples preceding and following a midpoint calibration check which fall outside the 15% limits will be reanalyzed after a new curve is prepared.

For HPLC, a daily retention time window shall be calculated for each analyte using the mean retention time from the initial midpoint calibration standard plus or minus three standard deviations as determined in the set-up QC section. If the retention time for any analyte from subsequent midpoint calibration standards falls outside the window, those sets of ten samples analyzed preceding and following that midpoint calibration standard must be reanalyzed after the problem is resolved.

8.4.2.2 Alternate Calibration for Unstable Operating Conditions for IC or FIA

Calibration will be performed with standards of five concentrations at the beginning of each day run singly. Concentrations will be as in 6.1.2.1. A midpoint calibration standard will be run at least every 10 samples and at the end of the run throughout the day. Any group of ten samples preceding and following a midpoint calibration check which falls outside the 15% limits will be reanalyzed

8.4.2.3 Calibration for CE

Calibration will be performed with standards of five concentrations at the beginning of each day run singly. Concentrations will be according to manufacturer's recommendations. A midpoint calibration standard will be run at least every 10 samples and at the end of the run throughout the day. Any group of ten samples preceding and following a midpoint calibration check which falls outside the 15% limits will be reanalyzed

8.4.2.4 Field Instrumentation QC

Field instrumentation quality control checks should be performed by measuring the calibrating solution immediately after calibration to ensure instrument response is as expected.

In the case of conductivity and pH, solutions prepared separately from the calibration standards should be used for this check instead.

Dissolved oxygen meters have no calibrating solution. A vigorously shaken water solution will be used as a check. Shaking saturates water with oxygen

8.4.3 Method Blanks

For NPLC, CE, IC, and FIA, one method blank shall be run with each batch.

8.4.4 Spike Samples

For NPLC, CE, IC, and FIA, one matrix spike shall be run with each batch.

8.4.5 Laboratory Control Samples

For NPLC, CE, IC, and FIA, one quality control check sample shall be run with each batch.

8.4.6 Duplicate Samples

For NPLC, CE, IC, and FIA, one duplicate or matrix spike duplicate shall be run with each batch

8.4.7 Definitions

Batch - Usually a group of no more than 20 samples of the same matrix prepared or extracted at the same time with the same reagents.

Note: If ALEA determines that use of automatic sample changers may be optimized by inclusion of more samples in a batch, up to 24 samples may be counted as a batch.

Method Blank - A sample of clean reagent carried through preparation and extraction in the same manner as samples. One method blank is run with each batch.

Surrogates - Chemicals not expected to be present in the samples to be analyzed but with chemical composition and behavior similar to the analytes under consideration. Surrogates are added before preparation and extraction to each test sample and quality control sample in a batch. Surrogate recovery is used to assess matrix effects and to monitor the performance of the extraction and analytical system. (Note—use of surrogates for CE is a slightly different topic from HPLC. As we become familiar with the technique, this paragraph may have to be amended.)

Matrix Spike - An aliquot of a sample spiked with a known concentration of all target analytes. Spike concentration is set to read at five times the method quantitation limit in the sample or about the midpoint of the calibration curve. One matrix spike is run for each batch. Spiking occurs prior to sample preparation and analysis.

Matrix Spike Duplicate - A second aliquot of the same sample treated in the same manner as the matrix spike.

Duplicate - A second aliquot of a sample taken independently through extraction and preparation before analysis.

8.4.8 Other QC Samples

When called for in the method, surrogates should be added to each sample, blank, and quality control sample before extraction or preparation.

The sampling organization may submit field blanks, field duplicates, reagent blanks, or trip blanks as instructed in the sampling plan. ALEA shall count these as samples in determining batch size.

8.4.9 Data Reduction, Validation, and Reporting

8.4.9.1 Data Reduction

Analytical data reported as a result of this project shall be calculated and reduced on vendor-supplied chromatographic software. If that software is not adequate to perform all calculations, any spreadsheets or programs developed to perform the calculations shall be documented in accordance with ALEA procedure GLP-0017, "Control of Changes to Software."

Chemical laboratory analysts are responsible for calculation and reduction of data.

8.4.9.2 Data Validation

Group supervisors or team leaders (analytical chemists or research chemists) are responsible for data validation. They are responsible for review and validation of analytical data produced in the project.

In supervisory review, data may be accepted on a "use as is" basis even though quality control checks fall outside limits provided a suitable technical basis is documented and the sample data are properly coded when reported.

8.4.9.3 Data Reporting

Analytical data are to be reported in units of micrograms per liter for liquid samples. Any results for solid samples should be reported as micrograms per kilogram dry weight. When moisture determinations are not possible, results should be reported either as micrograms per kilogram wet weight or some other indication shall be given to indicate what basis was used in reporting results. Method detection limits shall be reported or made available for each run. Surrogate recovery, recovery of matrix spikes, and recovery of quality control samples shall be calculated and reported as percentages.

Records of experiments and analyses shall be maintained for a period of three years after the end of the project. By the ALEA, a duplicate copy of all records shall be provided to the USAEC, Environmental Technology Division. This shall include machine printouts or chromatogram traces, logbooks, notebooks, logsheets, standard material use logs, raw data calculation sheets, etc. Computer media utilized to store analytical file backups or raw data files shall be stored for the lifetime of the project plus one year due to the limited lifetime of computer storage media.

8.4.10 Corrective Action

Corrective actions arising from nonconformance determined in the course of audits or analysis of performance evaluation samples shall be documented and tracked to completion.

8.5 Calculation of Data Quality Indicators

Data quality indicators shall be calculated as in Chapter 1 of SW-846, 3rd Edition.

8.6 Performance and System Audits

8.6.1 Performance Audits

For target compounds and NPDES compounds, the ALEA Quality Assurance Officer may introduce unknown quality control samples at a suitable frequency, provided reference material is available for constructing the samples. (Note: The lack of availability for commercially produced standard reference materials may make this impossible for all analytes.) Purchased quality control sample sets from reliable vendors should also be utilized for NPDES compounds.

USAEC may introduce blind quality assurance samples into the analytical stream at their discretion.

For NPDES compounds, ALEA shall participate in each EPA Water Pollution Study for each analyte studied in this project. ALEA shall investigate any analyte falling outside warning or control limits and report findings in writing to the QA Officer.

8.6.2 On-Site System Audits

The ALEA Quality Assurance (QA) Officer will periodically inspect logs, records, printouts, results of quality control checks, documentation, case narratives, research notebooks, and other quality related aspects of the project to ensure detailed compliance is in effect. Results of these inspections or internal audits will be reported in writing to the Laboratory Manager. Nonconformances will be documented and tracked in accordance with ALEA Procedure GLP-0005, "Nonconformance and Corrective Actions."

QA Audits, site inspections, surveillances, or performance evaluations (cross-check samples) may be performed by USAEC during the course of the project.

8.6.3 Contingency Laboratory

No contingency laboratory has been identified.

8.7 Quality Assurance Reports

8.7.1 Status Reports

TVA's project manager will provide monthly progress reports to USAEC which will contain a summary of accomplishments and a discussion of significant problems and their resolution. It will also contain a discussion of any Nonconformances and the corrective actions being taken to resolve them.

A quarterly quality control data report shall be written by the ALEA QA Officer addressing:

- Changes in this QA Project plan
- Changes in analytical procedures
- Summary of QC program results
- Summary of training
- Results of audits
- Results of performance sample evaluations
- Data quality assessment in terms of precision, accuracy, completeness, and MDLs
- Discussion of whether QA objectives were met

8.7.2 Audit Reports

Results of internal audits shall be reported in writing to the project manager within 10 working days of the completion of the audit.

Data Management and Analysis

Records of experiments and analyses shall be maintained for a period of three years after the end of the project. This shall include machine printouts or chromatogram traces, logbooks, notebooks, logsheets, standard material use logs, raw data calculation sheets, etc. Computer media utilized to store analytical file backups or raw data files shall be stored for the lifetime of the project plus one year due to the limited lifetime of computer storage media. Analytical data packages for the project shall include:

- Sample description or identification information
- Sample analytical results with surrogate recoveries
- Quality control sample results with surrogate recoveries and percent recovery of known compounds

Sufficient data will be maintained such that every analytical result could be reconstructed and every decision in development of the written procedures can be substantiated.

Unusable data shall not be reported. Data are unusable when quality control samples or quality control checks fail; however, the records for these attempts at analysis shall be maintained as will the relevant documentation. Under some conditions, data may be reported as not detected even though quality control checks fail, this will be considered sufficient, provided they are properly coded and the technical basis to report them is recorded. The relevant Data Qualification Codes are as follows:

SM - Surrogate recovery out of limits. Matrix effect suspected.

SD - Surrogate recovery low due to dilution. (Analyte concentration was so high that the sample had to be diluted to be analyzed.)

NA - Compound Not Analyzed

ND or <MDL - Compound not detected (value falls less than Method Detection Limit)

TR or Trace - Compound present at trace level, indicated but less than MDL.

MX - Matrix spike or matrix spike duplicate recovery was outside limits due to suspected matrix effects.

NDQ - Compound not detected (value falls less than Method Detection Limit) but quality control checks fell outside acceptance limits.

APPENDIX A

HEALTH AND SAFETY PLAN

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A-14.8	Attachment: TVA Form 255 (1/90) - Report of Vehicle Accident, Theft, or Fire (TVA Vehicle Only)	
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A-1.0 GENERAL

The project is being executed in two phases. Phase I involved a series of plant screening and treatability studies conducted off site. During Phase I, standard methods were developed to evaluate the ability of aquatic macrophytes (large-aquatic-plants) to lower the contaminant levels of TNT, RDX, and related compounds in explosives-contaminated water. Then, a variety of submergent and emergent aquatic macrophytes were screened for their ability to remediate the contaminated water. Finally, treatability studies were undertaken to test the performance of various wetland configurations. In Phase II, the field demonstration system will be designed, installed at MAAP, monitored, and evaluated from both a technical and economic perspective.

The demonstration system will consist of two constructed wetlands (figure A-1). The first will be a subsurface flow (SSF) type wetland, or gravel bed system, and the second will be a surface flow type wetland (more commonly referred to as a lagoon). Four wetland cells will be constructed with each wetland system consisting of two cells. Construction of the four wetland cells will utilize pre-formed poly panels bolted together to form above ground cells. Some excavation will be required in order to obtain additional cell depth as well as to assure adequate gravity flow between cells. In addition all cells will require some excavation and/or fill to compensate for grade variations of the site. Bracing and backfilling with soil will provide insulation and support for the above ground portion of the panels.

The cells will consist of a double lined system with leak detection. After proper excavation and the cell walls are in place, the first liner will be installed, which will serve as the secondary containment for the cells. On top of this bottom liner, 3 inches of gravel will be placed, followed by the second liner, which will serve as primary containment for the cells. A visual leak detection system will be provided between the two liners to monitor the integrity of the liners. Each liner will have geotextile fabric installed on both sides for puncture protection, and extend up over the top of the cells walls and secured. Piping penetrations through the liners will be made with manufacture approved boots. After installation of the liners and all pipe penetrations, and prior to the placement of gravel or soil, the cells shall be filled with water to a level above the highest pipe penetration, for leak testing.

PVC piping will be used for the influent and effluent headers, as well as the level control and sampling wells throughout the cells. These components will be placed in the cells and then the gravel (gravel bed system) or soil (lagoon system) will be installed. For freeze protection, most piping will be buried in trenches or submerged inside the cells. The small amount of exposed piping required will be high density polyethylene (HDPE) due to its high resistance to rupture caused by freezing temperatures.

All effluent flow from the cells will pass through granulated activated carbon columns (GAC) prior to discharge to the sewer. Sample connections will be provided to monitor the final effluent for removal efficiency as well as the useful carbon life. In order to have a gravity flow effluent from the cells, the GAC columns will be housed in a shallow pit. A watertight, insulated enclosure will be provided over the pit and heated during freezing weather.

To access sampling points within the lagoons, two boat decks, complete with boats, will be installed on the sides of the lagoons (Figure A-1). The boat deck will serve as both a place to secure and decontaminate the boats as well as a location to decontaminate equipment used to sample the lagoons. The floor of the boat decks will be sloped and covered with geotextile fabric such that liquids on the surface of the floor will flow into the lagoons.

Access to sampling points within the SSF wetland is obtained by simply walking upon the gravel bed of the wetland or by walking along the sides of the wetland area. (The water level will be 1-2 inches below the gravel beds).

The wetlands themselves will be installed within the boundaries of K-line at Milan. K-line is currently an inactive site and is secured by a security fence. Due to its inactive status, no Milan personnel routinely work in the area surrounding the demonstration site. The security fence is expected to prevent unauthorized personnel, wildlife (large animals), and livestock from entering the area surrounding the demonstration site.

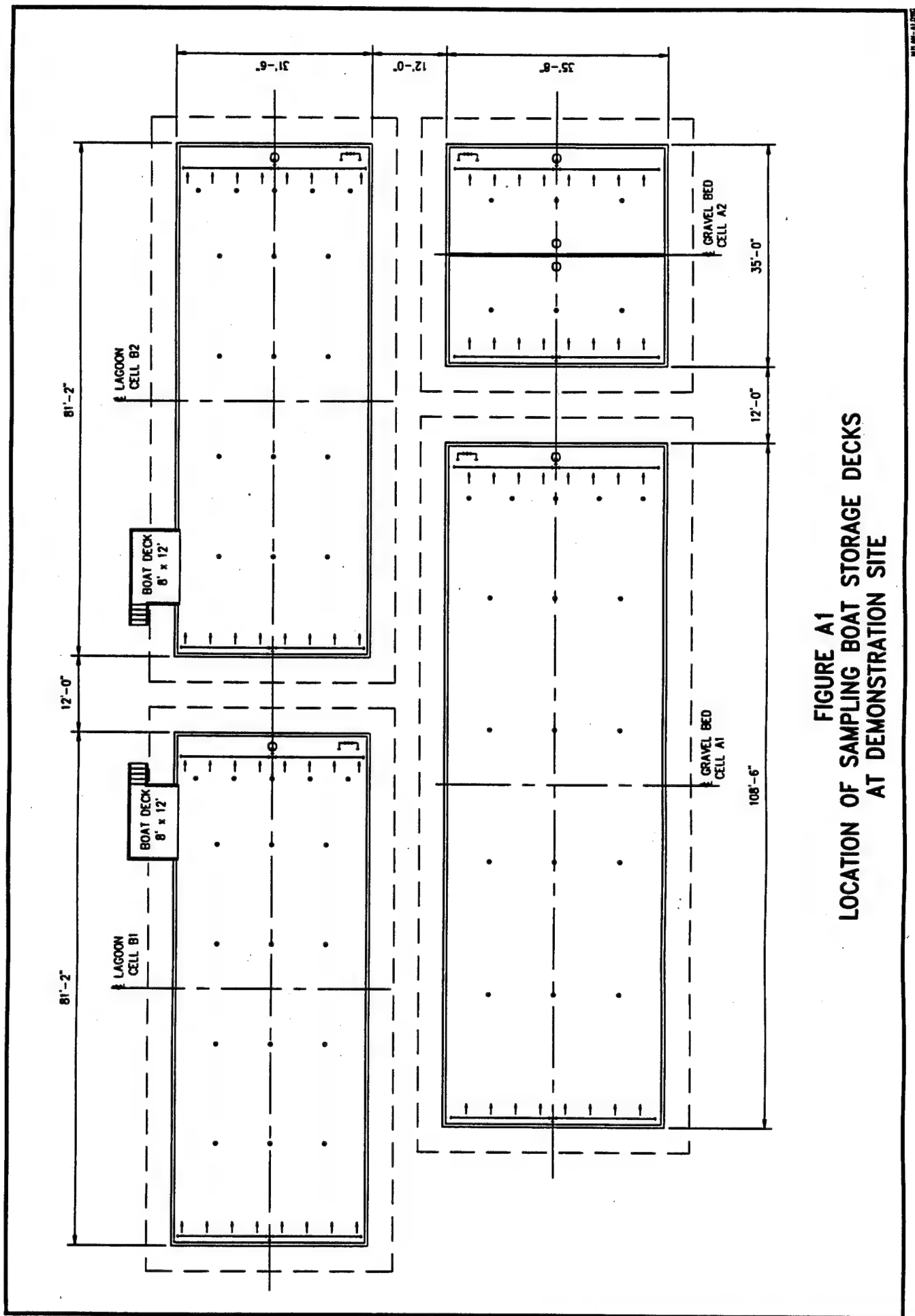


FIGURE A1
LOCATION OF SAMPLING BOAT STORAGE DECKS
AT DEMONSTRATION SITE

The overall risks associated with Phase I and II operations include:

- Low risk to those being in (or near) the area where low concentrations of explosive materials are handled.
- Moderate risk of accidental ingestion of explosive contaminated water.
- Moderate risk of fall and trip hazards as related to exposed piping.
- Moderate risk of back injury/strains from lifting heavy objects.
- Moderate risk of pinches, scrapes, cuts, and abrasions.
- Moderate risk exists from hazards associated with heat stress (heat cramps, heat exhaustion, heat stroke) and hypothermia.
- Low risk of being struck by heavy equipment
- Low risk of inhalation from dust hazards
- Low risk of drowning
- Low to moderate risk of snake and spider bites

Risks will be minimized by following safe work practice procedures and standard operating procedures during the construction phase and by the addition of decontamination procedures during the demonstration phase.

TVA's site manager will report to MAAP Commanding Officer with indirect reporting to MAAP Safety Director. All TVA field personnel will be under functional control of TVA's site manager.

A-2.0 KEY PERSONNEL

Milan Army Ammunition Plant:

Position	Name	Phone Number(s)
MAAP Government Contact	Pat Brew	(901) 686-6291
MAAP LMOS Contact	Mike Robinson	(901) 686-6727
MAAP Safety Director	Bill Bible	(901) 686-8482 or 6681

Tennessee Valley Authority:

Position	Name	Phone Number(s)
Project Manager	Rick Almond	(205) 386-3030
Site Manager	Steven Coonrod	(205) 386-2929 or (205) 810-2167
Safety Director	Steven Coonrod	(205) 386-2929 or (205) 810-2167

A-3.0 MAPS OF WORK AREAS

Figures 1 through 4 of the Demonstration Plan (Sections 1.0 and 3.0) indicate the areas within MAAP in which TVA personnel will be working. Most of the work will be within these boundaries. Visits to other parts of MAAP may require a guide or escort.

A-4.0 PERSONNEL PROTECTIVE CLOTHING AND EQUIPMENT

A-4.1 GENERAL

As a minimum, the Milan Army Ammunition Plant Accident Prevention Program and the TVA Environmental Research Center's Chemical Hygiene Plan (Attachment A-14.1) will serve as TVA's personnel protective clothing and equipment guide. All protective clothing and equipment must meet the minimum standards prescribed by ANSI, OSHA, and TVA.

A-4.2 RESPONSIBILITIES

The TVA site manager will have overall responsibility to ensure that all TVA personnel utilize the protective clothing and equipment prescribed of a particular job. Each individual shall be familiar with the necessary clothing and equipment to do their job and shall keep all items serviceable at all times.

Any faulty equipment shall be reported to the appropriate TVA personnel for repairs and or replacement. TVA personnel shall not attempt to repair any equipment other than that belonging to TVA.

A-4.3 SITE CONTAMINATION

The soil at the area selected for the demonstration will be monitored for contamination with hazardous materials. The monitoring effort will consist of collecting soil samples at the demonstration site and analyzing those samples for the presence of hazardous materials both before and after the demonstration. The monitoring effort will be performed by the of U.S. Army/operating contractor representatives at Milan. To date, Jan 30 1996, the Army had indicated that they have no reason to believe that the soil at the demonstration site is contaminated with any hazardous material. However, actual collection of soil had not yet occurred. Construction of the demonstration facility will not commence prior to approval from the Army and certification that the soil is not contaminated. Should it be determined that the soil is contaminated, procedures will be put in place to protect the construction workers and to decontaminate construction equipment.

The fate of the wetlands facility, after the demonstration, has not been decided. Hence, procedures for decontaminating and decommissioning the demonstration unit are considered outside the scope of this test plan.

A-4.4 SITE CONTROLS

After the construction phase, and prior to beginning the demonstration, TVA will establish site controls. These controls will consist of a designation of work areas for sampling collection and decontamination of equipment/personnel. The most likely work area will consist of the area immediately surrounding the test cells. In designating the work areas TVA will take into consideration the need to minimize work area size as well as the need to safely obtain samples and maintain the health of the wetlands.

Movement within the work area will be restricted to personnel directly involved in:

- Assessing or maintaining the wetlands,
- Obtaining samples.

Access to the work areas will be restricted by the use of access restriction tape and signs indicating that access to the work area is restricted. The presence of the existing security fence around K-line will provide additional control by limiting access to the demonstration site.

A-4.5 DECONTAMINATION MEASURES

Equipment/personnel decontamination will occur on the boat deck and/or on gravel bed of the SSF wetlands. Each of the two lagoons will be equipped with boats for sampling. The boats will be stored on decks located along lagoons so that contaminated water from the boats will drain into the lagoons (Figure A-1). All materials leaving the cell will be placed on a sheet of liner so contaminated water can be collected and returned to the treatment system. All rinse water will be collected and returned to the experimental cell or passed through the carbon treatment system.

When feasible, equipment/personnel being decontaminated will be decontaminated at the cell being sampled. However, plant density on the SSF cells may restrict the ability to decontaminate on the gravel beds of the SSF cells. In this instance equipment needing decontamination will be placed in a plastic container (to prevent dripping contaminated water onto the soil) and be decontaminated at one of the boat decks attached to the lagoons. Decontamination of personnel at the SSF cells is not expected to be a serious problem given that personnel cannot fall into the water.

All equipment in contact with contaminated water will be decontaminated by washing three times with distilled water using a common garden type hand sprayer. Distilled water will be used in preference to chlorinated water which could detrimentally affect single celled organism in the test cells.

Given that the primary hygiene concern is the presence of water that may not meet drinking water standards, the primary decontamination personnel will under go is the rinsing of hands prior to leaving the designated work area. Decontamination will be achieved by a rinsing of the hands three times with distilled water via the use of a common garden type hand sprayer.

However, given that the open lagoons provide an opportunity to fall into the contaminated water, personnel having body contact with the contaminated water will be stripped of all clothing and rinsed three times. The contaminated clothing will be secured in a plastic bag and taken to Milan's laundry for cleaning. Replacement clothing will be provided onsite.

A-4.6 SAMPLING ACTIVITIES

Sampling activities will involve the collection of water, soil, and plant samples at various location around the demonstration site (see section 6.0 of test plan for a detailed listing of samples to be obtained). Risks associated with theses activities include:

- Moderate risk of accidental ingestion of explosive contaminated water.
- Moderate risk of snake and spider bites.

- Moderate risk of fall and trip hazards as related to exposed piping.
- Moderate risk of pinches, scrapes, cuts, and abrasions.
- Moderate risk from hazards associated with heat stress (heat cramps, heat exhaustion, heat stroke) and hypothermia.
- Low risk of drowning.

The samples being obtain are not likely to be highly toxic, under extreme pressure, or present at unusually low or high temperatures. However, the presence of low levels of explosive contaminated water will dictate prudent handling to insure against accidental ingestion and decontamination procedures will be followed (see section 4.5).

Normally sample collection will be achieve by walking to the sampling site and obtaining the sample. At the lagoons, however, samples will be obtained by entering a boat and rowing to the appropriate location within the lagoon. This procedure opens up an increase in the probability of accidental:

- Emergence in contaminated water,
- Ingestion of contaminated water
- Drowning

Given that the level of explosive contamination is low, and the depth of the water in the lagoons is only about two feet, it is unlikely that such a event will result in severe injury. Never-the-less anyone immersed in the contaminated waters will undergo decontamination per section 4.5 and all personnel working on the boats will be required to wear a life jacket. Further any personnel subject to ingestion of contaminated water , or suspected of having ingested contaminated water, will be subject to medical evacuation and evaluation.

A-4.7 PROTECTIVE CLOTHING AND EQUIPMENT

Currently the known level of hazards present at the demonstration site does not appear to warrant the use of protective clothing beyond that normally required for construction or sampling activities. However, should this perception change TVA will provide the necessary

including, but not limited to: gloves, rubber gloves, safety goggles, coveralls, and hard hats. All protective clothing and equipment will be stored in TVA's van or Buildings K9 and K100.

All items received from the MAAP will be accounted for and returned to MAAP prior to TVA's departure from Milan Army Ammunition Plant at the completion of the demonstration project.

A-4.8 SAFETY GLASSES

TVA will provide all TVA personnel with safety glasses or goggles as appropriate to the situation. TVA personnel requiring prescription glasses shall be provided prescription safety glasses by TVA. Contact lenses will not be worn on site.

A-4.9 HARD HATS

TVA personnel will be issued TVA hard hats. The hard hats will be worn when entering a designated hard hat area. TVA will provide a hard hat storage area for TVA personnel not working in designated hard hat areas. The demonstration site is not a designated hard hat area and will not be considered a hard hat area during the demonstration. However, the demonstration site will be considered a hard hat area during the construction phase.

A-5.0 TRAINING

A-5.1 GENERAL

TVA personnel involved in the field work at MAAP and laboratory analysis to be working with explosive-contaminated water at Muscle Shoals, Alabama, shall be trained by personnel at MAAP as per MAAP's minimum safety and security requirements for contractors (Attachment 14.2).

A-5.2 LABORATORY PLAN/PROTOCOL

All TVA laboratory personnel guided by the TVA's approved Chemical Hygiene and Health and Safety plans for handling samples for analysis. These plans are based on established practices for hazardous and toxic materials and the specific requirements of the explosive being tested. The Laboratory Protocol (Appendix B) and Methods and Procedures (Appendix A) of the TVA plan cover all laboratory analysis and field sampling procedures.

A-5.3 ON SITE TRAINING

Upon arrival at MAAP, in conjunction with in-processing and set-up, TVA personnel shall receive site specific training and orientation as deemed necessary by MAAP/TVA.

All pertinent subjects shall be covered to include but not necessarily limited to:

- Site security
- Site safety precautions/regulations
- Site warning signals
- Site orientation and facility locations
- Site specific rules and regulations
- Severe weather warnings/conditions/actions
- Emergency response actions

A-6.0 MEDICAL PROTOCOL

A-6.1 KEY MEDICAL PERSONNEL

Key medical personnel necessary to support any emergencies will be the emergency medical technicians (EMT) provided by the MAAP fire department. In the event of an accident or illness beyond the scope of the EMT, the Milan Hospital located in the city of Milan, Tennessee, would be used. Figure A-2 illustrates the highway route from MAAP to Milan, Tennessee and shows the location of Hospital. The city of Milan Hospital and Emergency Medical Center is within 10 minutes of the site.

TVA's site manager will coordinate all field activities (through MAAP's staff) with the emergency medical facilities at MAAP. This will ensure appropriate medical coverage and support is always available in the event a medical emergency occurs.

A-6.2 EMERGENCY PHONE NUMBERS

Key emergency telephone numbers are provided in Table A-1

A-6.3 EMERGENCY RESPONSE EQUIPMENT

The Milan Army Ammunition Plant fire department will provide emergency response equipment and personnel within the MAAP boundary. All TVA personnel will adhere to the MAAP/TVA standard operating procedures for emergency response. Emergency response actions and responsibilities will be included in the initial briefing received by TVA upon arrival at MAAP.

TVA will provide Material Safety Data Sheets (MSDS), or equivalent information, to include health hazard information and chemical and physical properties, of all chemicals brought on

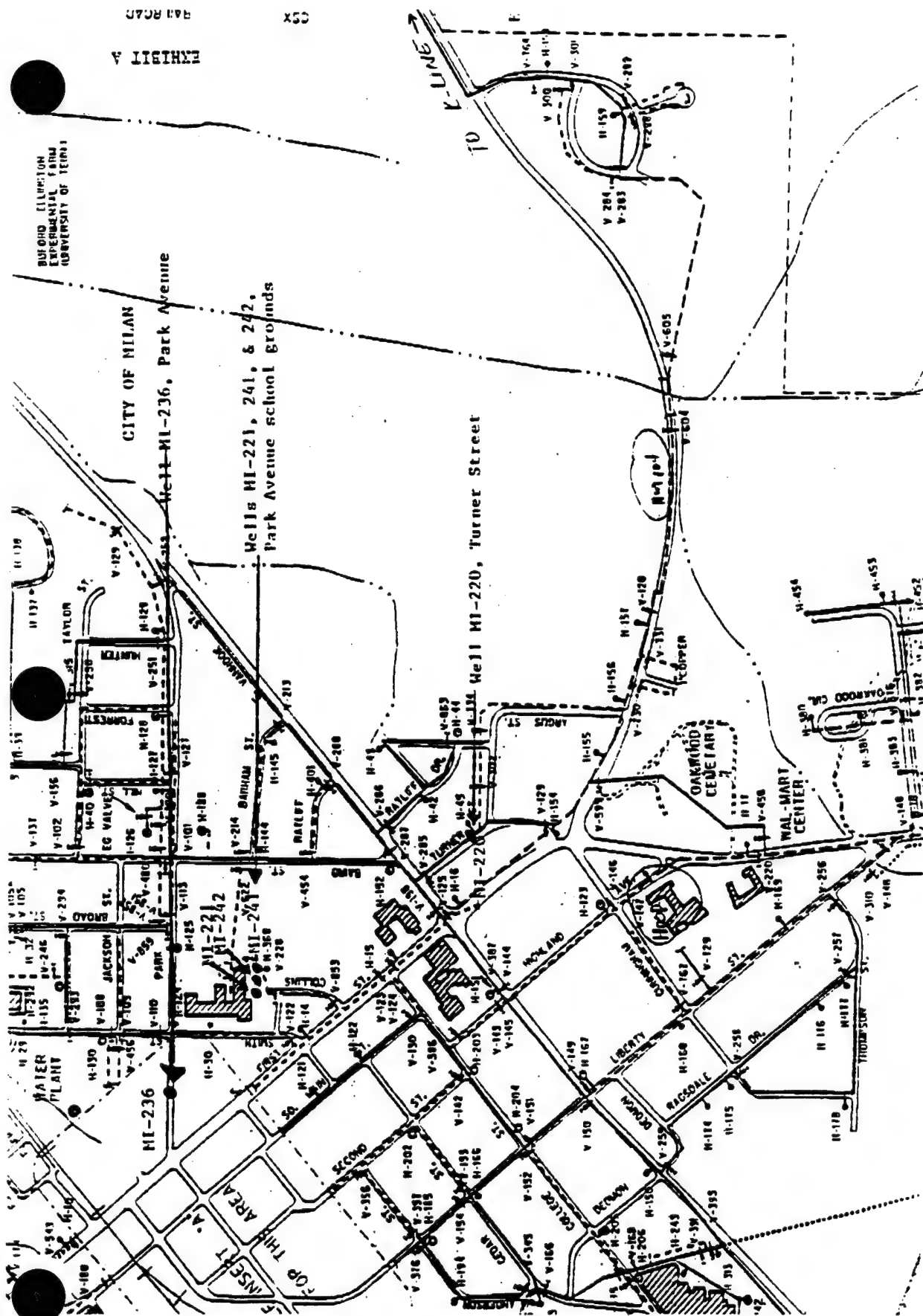


Table A-2
Highway Route from MAAP to Hospital In Milan, Tennessee

Table A-1 - Emergency Telephone Numbers

Service	Number
Ambulance (Milan)	17 or 911
Police	6565 or 911
Fire	17 or 911
Safety	6482 or 777
City of Milan Hospital	(901) 686-1591
Poison Control Center	(212) 764-7667
National Response Center	(800) 424-8802
Chemtrec	(800) 424-9555
MAAP Installation Safety Division	(901) 686-6565
MAAP Environmental Division	(901) 686-6195
NIOSH: Health Hazard Evaluation	(513) 684-4382
OSHA: Technical Data Center	(202) 523-9700

site, to the MAAP fire department. The information will include a list of all chemicals, quantities, and storage locations. TVA will also maintain the same information in building K-9.

MSDS's will be provided at any time additional chemicals are purchased and delivered to MAAP. All listings will be kept current.

A-6.4 FIRST AID PROCEDURES

All TVA employees are familiar with first aid procedures. A first aid instructional manual for TVA employees is provided in Attachment A-14.3. TVA field personnel have been trained in CPR techniques.

TVA's site manager will coordinate any additional training or first aid-related subjects with the safety office at MAAP. This will be handled with assistance from the Safety Officer at MAAP.

PERSONAL HYGIENE

Eating, drinking, chewing, and smoking will be prohibited within the working area. Only areas designated for that purpose will be used. Personnel will be required to wash their hands prior to eating and at any time following the use of chemicals and contaminated explosive items and at any time contamination is expected.

Smoking materials such as cigarettes, cigars, pipes, matches, lighters, etc., will not be permitted in the work area. All such items will be left in the areas designated by MAAP and not carried on the person.

A-8.0 PERSONNEL REQUIREMENTS

The TVA project management team will consist of the following:

- 1 - Project Manager
- Engineers - As required
- Project Engineers - As required
- Computer Analysts - As required
- Others - As required

The TVA field team will consist of the following:

- 1 - Site Manager
- Professionals (SD and SC) - As required
- Engineering Aides (SE) - As required

The TVA laboratory analysis team will consist of the following:

- 1 - Laboratory Manager
- 1 - Quality Assurance Officer
- Research Chemists - As required
- Chemical Laboratory Analysts - As required

A-9.0 VISITOR POLICY

All visitors to MAAP will be required to sign in through the MAAP security office to obtain a visitor's badge and vehicle pass or be accompanied by TVA personnel with a crew badge. All visitors to the site are required to sign in with the TVA site manager to record the visitors name and purpose of the visit. A daily log will be maintained by the TVA site manager of all activities during the project.

A-10.0 SUPPORT FROM MAAP AND TVA

MAAP maintains qualified and trained Emergency Medical Technicians (EMT), fire fighting personnel, environmental officers, and safety officers on site. EMTs and fire fighting personnel are on duty 24 hours per day. MAAP EMTs will provide rapid response to emergencies and transportation to designated local hospitals.

MAAP's Administrative Contracts Officer will serve as TVA's point of contact with TVA as well as the initial contact for assistance for other MAAP offices (i.e., medical, environmental, safety, and fire).

A-11.0 EMERGENCY CONTINGENCY PLAN/ACCIDENT REPORTING

A-11.1 EMERGENCIES

Should events, incidents, or accidents occur beyond the scope of this plan, TVA personnel will take direction from MAAP or TVA to evacuate the plant site to a safe location as designated. Return to normal duties will follow an "all clear" notification from MAAP.

A-11.2 ACCIDENTS AND REPORTS

Accidents resulting in a fatality, lost-time injury or illness, hospitalization of three (3) or more personnel, or property damage to government or contractor property (which occurred during the performance of the contract) equal to or exceeding \$2,000.00 must be telephonically reported to the U.S. Army Environmental Center (USAEC), SFIM-AEC-TSS, phone number (410) 671-4811, as soon as possible, but not later than two (2) hours after occurrence and reported in writing within five (5) days of occurrence on DA Form 285 (Attachment A-14.4). Additional forms may be obtained from the MAAP Safety Office. The above procedure are designed to meet OSHA regulations requiring notification of fatalities or hospitalization of three or more personnel within 8 hours of learning of the accident either verbally or by written communication. All other accidents/incidents must be telephonically reported to USAEC, SFIM-AEC-TSS, phone number (410) 671-4811, within eight (8) hours of occurrence.

Accidents will also be reported using TVA protocol and procedure (Attachment A-14.5, TVA Safety Program - Management Practice/Serious Accident Investigation, Procedure Number TVA/DASHO/STD/ALL/X.X) through TVA's chain of command and using the appropriate TVA forms and instructions. Accident reporting forms include:

- Form CA-1 Federal Employee's Notice of Injury (Job Related) – Attachment A-4.6
- TVA 91 79 Claim of Disability (Job Related) – Attachment A-14.7
- TVA 255 TVA Report of Vehicle Accident, Theft, or Fire – Attachment A.14.8
- SR 13 Alabama Department of Public Safety (Private Vehicle) – Attachment A-14.9

A-12.0 SECURITY

A-12.1 GENERAL

The facilities and equipment at Milan Army Ammunition Plant, Milan, Tennessee, as well as the plans, methodologies, and literature contained in this document, are 'unclassified' concerning national security. Security, as it relates to personnel-allowed access to buildings, will be imposed to control personnel at the test site. MAAP security personnel will control the public's access to MAAP.

A-12.2 SITE CONTROL MEASURES

MAAP security will control access to all sites within the plant area. Portable barricades in conjunction with existing gates may be used to control access when necessary.

A-12.3 BADGES

TVA personnel will be issued permanent non-escorted identification badges upon arrival at MAAP. These badges will be issued in accordance with normal and routine MAAP security procedures and all badges will be surrendered to MAAP security department upon completion of this field demonstration period.

A-12.4 VEHICLES

TVA's vehicles, whether U.S. Government vehicles or rental units, will be allowed at MAAP according to normal security SOP (standard operating procedure). TVA vehicles will be subject to all governing rules and regulation enforceable at the time the test plan is executed.

A-12.5 CAMERAS

All TVA personnel will be required to register cameras with MAAP's security department upon arrival. A camera pass will be required for each camera carried on site.

A-12.6 ACCESS

TVA's site manager will control access to the TVA demonstration facilities in coordination and cooperation with MAAP/TVA. However, security for this operation will be under the direct supervision of MAAP security personnel in strict compliance with all enforced procedures and regulations.

A-12.7 FIREARMS

TVA personnel will not be allowed to carry firearms on MAAP.

A-13.0 SIGNATURES

All TVA personnel related to the wetlands project will read this health and safety plan and sign the form in attachment 14.10 to certify they, the undersigned, have read this Health and Safety Plan, understand its contents, and will comply with all provisions contained herein. (This record will be kept on site.)

A-14.0 ATTACHMENTS

A-14.1 **ATTACHMENT: 1996 Chemical Hygiene Plan, TVA Environmental Research Center,**
Biotechnology Department

1996

CHEMICAL HYGIENE PLAN

TVA

ENVIRONMENTAL RESEARCH CENTER

BIOTECHNOLOGY DEPARTMENT

September 26, 1995

Center Employees

CHEMICAL HYGIENE PLAN FOR THE CENTER

The most recent revision of the Chemical Hygiene Plan for the Center is attached as is a copy of the text of Title 29 of the Code of Federal Regulations part 1910.1450. Please review this document and keep it in your files.

The plan was reviewed and revised by a team consisting of the Chemical Hygiene Officers: Liz Bailey, Sheryl Cannon, Tim Holt, Robert Johnson, and Bill Rogers. If you have questions about the document, its applicability, its interpretation, or implementation, please contact one of the Chemical Hygiene Officers.


William J. Rogers, CTR 1K-M

WJR:PJM

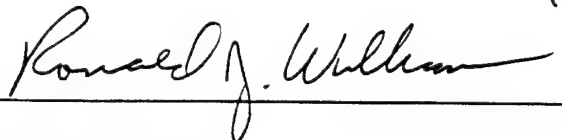
Attachment

cc (Attachment):

Files, Center, CEB 1C-M

Chemical Hygiene Plan .
Environmental Research Center
Revision 3
September 30, 1995

Approved by:

A handwritten signature in cursive script, reading "Ronald J. Williams", is written over a horizontal line.

Ronald J. Williams
Acting Manager
Environmental Research Center

REVISION LOG

- A. Change documentation of quarterly qualitative hood checks to add "or by memorandum to files."
- B. Revise lists of Chemical Hygiene Officers and Building Emergency Response coordinators.

1.0 Purpose

1.1 This Chemical Hygiene Plan has been developed to set forth administrative procedures to meet the requirements of Title 29 of the Code of Federal Regulations (29CFR), Part 1910.1450.

1.2 The Chemical Hygiene Plan has as its goal to protect employees from health hazards associated with hazardous chemicals in the laboratory.

2.0 Scope

2.1 This Plan applies to work and work areas in the Environmental Research Center involving the laboratory use of hazardous chemicals as defined in 29CFR 1910.1450.

3.0 Definitions

3.1 The following terms are used in this Plan as defined in 29CFR 1910.1450:

chemical hygiene plan, chemical hygiene officer, hazardous chemical, laboratory, laboratory-type hood, laboratory use of hazardous chemicals, medical consultation, physical hazard, reproductive toxins, select carcinogen

3.2 OSHA - Occupational Safety and Health Administration

3.3 Action Levels - Action levels are specified in 29 CFR part 1910 subpart Z for certain chemicals. In their absence, OSHA permissible exposure limits (PEL's) are to be used. However, TVA has committed to a further set of exposure limits as specified in the TVA Occupational Health and Safety Standard Number 014, "Threshold Limit Values (TLV's)". References to "action levels" in this Plan refer to whichever of these limits is less.

3.4 TVA - Tennessee Valley Authority

4.0 Responsibilities

4.1 Team leaders who are responsible for work which meets the definition of "laboratory use of hazardous chemicals" shall be responsible for implementation of this Plan within their team.

4.2 Each team leader who is responsible for work which meets the definition of "laboratory use of hazardous chemicals" shall appoint a Chemical Hygiene Officer (CHO) who is qualified by training or experience to provide technical guidance in the development and implementation of the provisions of this Plan in that team. Should other CHO's be needed at a lower level of

organization, nothing in this Plan prohibits their appointment. See Attachment 1 for a current list of CHO's.

4.3 The Chemical Hygiene Officers shall provide technical guidance in the development and implementation of the Plan, shall serve as *ex officio* members of their teams' Chemical Hygiene Committees, and shall ensure adequate training is provided to ensure compliance with this Plan.

4.4 The CHO's shall ensure hood flows are measured annually as required by this Plan. The CHO's should ensure hoods are checked qualitatively on a quarterly basis.

4.5 The CHO's shall ensure all hazardous chemicals used in laboratory work are properly inventoried.

4.6 The CHO's shall ensure records required by this standard are retained for the proper period of time.

4.7 The CHO's shall meet annually to review the contents of this Plan and revise it as needed.

4.8 The Chemical Hygiene Committee (CHC) shall be made up of the team's safety committee and the CHO. Should this committee lack expertise in problems of chemical hygiene, additional assistance may be requested as needed from the CHO's of other teams or any other professional in TVA with suitable knowledge.

4.9 The CHC shall include the criteria of this Plan in its routine inspections.

4.10 The CHC shall review activities involving hazardous chemicals in category C (see below). The results of these reviews shall be documented in writing. In these reviews, the CHC shall give particular attention to the following:

Establishment of designated areas for use.

Use of containment devices such as fume hoods or glove boxes.

Procedures for safe removal of contaminated waste.

Decontamination procedures.

5.0 Chemical Inventory

5.1 A current, complete chemical inventory shall be maintained for the Center.

5.2 For the purposes of this Plan, chemicals in the laboratory are classified into three categories:

A. Materials with low toxicity. Materials with physical hazards commonly encountered in laboratory work. Those chemicals for which no protective equipment other than the routinely used gloves, safety glasses, and lab coats are required. This category may contain dilute solutions of chemicals in category B below.

B. Moderately-toxic materials, highly toxic materials, or materials with substantial physical hazard associated with their use. Those chemicals which must be used in a laboratory-type hood or with additional protective clothing such as aprons, goggles, face shields, blast shields, or special gloves.

C. Those chemicals which are described in 29CFR 1910.1450 as "select carcinogens," reproductive toxins, or substances which have a high degree of acute toxicity. (See 29CFR 1910.1200 Appendix A.)

6.0 Employee Protection/Standard Operating Procedures

6.1 Suitable engineering controls shall be provided to ensure employee protection.

6.2 The rules and requirements of the "Manual of Safe Work Practices", October 1990, Resource Development, Tennessee Valley Authority, shall be the standard operating procedures for safe work activities in work areas falling under the scope of this Plan.

6.3 Employee Exposure

6.3.1 For laboratory uses of OSHA regulated substances, employees shall not be exposed to levels exceeding those specified in 29CFR part 1910, subpart Z or other levels adopted by TVA (see the definition of action level).

6.3.2 If there is a reason to believe that exposure levels for any substance for which a standard requires monitoring routinely exceed OSHA or TVA action levels or TLV's, the CHC shall request that the exposure be measured.

6.3.3 If the initial monitoring prescribed by the paragraph above discloses employee exposure over the TVA or OSHA action level or TLV's, TVA shall immediately comply with the exposure-monitoring provisions of the relevant standard. Monitoring may be terminated in accordance with the relevant standard. Employees shall be notified in writing of monitoring results in accordance with 29CFR 1910.1450.

6.4 A Laboratory Emergency Plan is provided in Appendix I. It shall be used unless superseded by a more specific set of guidelines for any team.

6.5 Each team shall develop a written Waste Management Plan for hazardous substances.

6.6 Additional Requirements

6.6.1 Chemicals in category B which produce fumes, vapors, or dust shall be used in a laboratory-type hood.

6.6.2 Those chemicals in category B which require the use of other appropriate protective equipment such as aprons, goggles, face shields, blast shields, or special gloves shall be used with the appropriate protective equipment.

6.6.3 Chemicals in category C shall not be used unless a review is performed and written approval of the use is made by the CHC. Use of these chemicals shall not be made unless appropriate control measures are in place and functioning to prevent employee exposure.

6.6.4 Chemicals in category C shall be required to be used in designated areas by the CHC where appropriate.

7.0 Laboratory-type Hoods

7.1 Laboratory-type hoods shall not be used unless they are functioning properly.

7.2 Laboratory-type hoods shall be inspected and tested annually by an industrial hygienist to ensure compliance with all appropriate federal guidelines. The results of this test and the guidelines to which the inspection was made shall be documented.

7.3 Quarterly, hoods should be checked qualitatively for flow. This check need only be performed in the three quarters in which the annual test was not performed. This test shall be documented on the exterior surface of the hood.

7.4 Employees shall check laboratory-type hoods to ensure they are operating before using them.

8.0 Information and Training

8.1 Prior to assignment to a work area where hazardous chemicals are present or prior to assignments involving new exposure situations, employees shall be provided information apprising them of the hazards of chemicals present in the work area.

8.2 Employees shall be informed of

The contents of 29CFR 1910.1450 and its appendices

The location and availability of this Plan

The permissible exposure limits for OSHA-regulated substances

Recommended exposure limits for other hazardous chemicals for which there is no applicable OSHA standard (see TVA OHS Standard 014)

Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory

The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory - this includes but is not limited to Material Safety Data Sheets (MSDS) and a bookshelf in the Muscle Shoals Technical Library containing commonly-cited references.

8.3 Employees shall receive a copy of 29CFR 1910.1450 and its appendices.

8.4 Employee training shall include:

Methods and observations that may be used to detect the presence or release of a hazardous chemical such as visual appearance and odor.

The physical hazards of chemicals in the work area.

The health hazards of chemicals in the work area.

Measures which shall be taken to protect employees from these hazards such as appropriate work practices, emergency procedures, and protective equipment.

Applicable details of this Plan.

8.5 Training shall be documented. This documentation shall include attendance rosters, detailed outlines of training material, and results of any tests.

9.0 Medical Consultation and Examination

9.1 Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

9.2 Where exposure monitoring reveals an exposure level routinely above the action level (or PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

9.3 Whenever an event takes place in the work area such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be

provided an opportunity for a medical consultation for the purpose of determining the need for a medical examination.

9.4 All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee without loss of pay and at a reasonable time and place.

9.5 TVA shall provide the following information to the physician:

The identity of the hazardous chemicals to which the employee may have been exposed.

A description of the conditions under which the exposure occurred including quantitative exposure data, if available.

A description of the signs and symptoms of exposure that the employee is experiencing.

9.6 For examinations or consultations required under the scope of 29CFR 1910.1450, the Tennessee Valley Authority shall be provided a written opinion from the examining physician which shall include recommendations for further medical follow-up, the results of the medical examination and any associated tests, any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical in the workplace, and a statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment. The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

10.0 Recordkeeping

10.1 Records of training, inspections, reviews, revisions to the Plan, and decisions of the CHC shall be kept for three years from the date the document was produced unless other recordkeeping requirements mandate a longer retention period.

10.2 Records of any measurements taken to monitor employee exposure and any medical consultations and examinations including tests or written opinions shall be kept for the duration of employment plus thirty years.

11.0 Annual Review

11.1 Annually, the various chemical hygiene officers shall meet to review the this Plan for effectiveness and update it as necessary.

APPENDIX I

Laboratory Emergency Plan

12.0 This appendix provides guidance for emergencies in laboratories. This section is not exhaustive and is not intended to cover every possibility, but rather is intended to give guidelines for the more commonly encountered emergency situations.

12.1 This appendix does not supersede any emergency procedures, rules, regulations, or administrative decisions promulgated by any other group within the Tennessee Valley Authority.

12.2 In various types of emergency, the building emergency team coordinator (see attachment 2), Public Safety (8911), Medical, or the supervisor may need to be contacted. In any emergency, do not hesitate to call on any of these for assistance. Do not be concerned about correct protocol, rather obtain as much help as needed. Err on the side of getting too much help rather than too little.

12.3 Evaluation and Evacuation

Any emergency situation such as a small spill, small fire, runaway reaction, personal injury, loss of power, loss of cooling water, or any other unforeseen circumstance shall be immediately evaluated by the persons present. If it cannot be handled without the chance of personal injury, evacuate and notify the building emergency team coordinator, Public Safety, and the supervisor of the work area. If there is potential for the emergency situation to endanger others, notify them and clear the work area.

If the situation is urgent, call loudly for help.

12.3.1 Personal Injury

12.3.1.1 Chemicals in the Eye

If chemicals get in the eye, go to the nearest eye wash station and flush the eyes with water, holding them open. Call loudly for help. While this is being done, someone else should contact Medical or Public Safety for further instructions. Continue flushing for at least 10 minutes or until instructed otherwise.

12.3.1.2 Chemical Contact with Skin

If only small areas are involved such as the hands or forearms, wash with plenty of soap and water.

If chemicals are splashed on the body or clothing, flood the areas immediately with plenty of water. Use the nearest safety shower. Remove any clothing or shoes soaked with chemicals.

Water-reactive chemicals, of course, should not be flushed with water. Guidelines for handling such a situation should already be established. When in doubt, contact the supervisor or other knowledgeable person for instructions.

After washing, inspect the body, clothing, shoes, and jewelry immediately for lingering traces of the chemical. Do not replace clothing, shoes, or jewelry until it is certain all traces of the chemical are removed.

If a hazardous substance is involved, notify the supervisor.

12.3.1.3 Minor Injury

Minor injury may be treated with the first aid kits. Notify the supervisor. The supervisor shall make an evaluation whether the employee must go to medical. If there is any doubt, escort the employee to Medical.

12.3.1.4 Other Injury

Escort the injured employee to Medical and contact the supervisor. A trained person should apply first aid as necessary before going to Medical. If the employee is unable to walk or if there is any indication the injury is more than can be handled with minor first aid, contact both Public Safety and Medical for further instructions.

12.3.1.5 Imminent Danger

Any person injured and unconscious shall not be moved by untrained personnel unless there is imminent danger of death.

12.3.2 Fire

12.3.2.1 Small Fires

Small fires may be handled by smothering them or using a fire extinguisher. Do not use water on flammable liquids. Contact the supervisor immediately as well as Public Safety.

12.3.2.2 Other Fires

Evacuate and call Public Safety. Pull the nearest fire alarm lever.

12.3.3 Spills

Contain the spill by using a spill kit corresponding to the material. Follow the directions on the spill kit. Notify the supervisor.

If the spill is too large to be contained by the spill kit or if toxic fumes are present, evacuate the work area. Notify the building emergency team coordinator. Notify people in adjoining work areas. Notify the supervisor.

12.3.4 Other

Other situations such as power failures or loss of cooling water shall be handled as well as possible by those involved. Adhere to the following guidelines.

12.3.4.1 When in doubt, evacuate. Notify the building emergency team coordinator as well as others in adjoining work areas.

12.3.4.2 Place a higher value on human life and safety than on equipment or buildings. Take no risks which might endanger any person to save a piece of equipment or a building.

12.3.4.3 Notify the responsible supervisor and Public Safety.

ATTACHMENT 1

Chemical Hygiene Officers

Land and Water Sciences -	Sheryl Cannon	(3078)
Atmospheric Sciences -	Liz Bailey	(3645)
Biotechnology -	Robert Johnson	(2654)
Biotechnology -	Tim Holt	(2044)
Analytical Laboratory -	Bill Rogers	(3774)

ATTACHMENT 2

Building Emergency Team Coordinators

Environmental Research Center -
Chemical Engineering Building -

Paul Enlow
Steve Diamond

(3770)
(3386)

employers have employees exposed to the initial employer's chemicals?

Is the written program made available to employees and their designated representatives?

Does the program adequately address the methods of communicating information to employees in your workplace, and provides answers to the basic questions outlined above, it will be found to be in compliance with the rule.

5. Checklist for Compliance

The following checklist will help to ensure you are in compliance with the rule:

Obtained a copy of the rule. _____
Read and understood the requirements. _____

Assigned responsibility for tasks. _____
Prepared an inventory of chemicals. _____
Ensured containers are labeled. _____
Obtained MSDS for each chemical. _____
Prepared written program. _____
Made MSDSs available to workers. _____
Conducted training of workers. _____
Established procedures to maintain current program. _____
Established procedures to evaluate effectiveness. _____

6. Further Assistance

If you have a question regarding compliance with the HCS, you should contact your local OSHA Area Office for assistance. In addition, each OSHA Regional Office has a Hazard Communication Coordinator who can answer your questions. Free consultation services are also available to assist employers, and information regarding these services can be obtained through the Area and Regional offices as well.

The telephone number for the OSHA office closest to you should be listed in your local telephone directory. If you are not able to obtain this information, you may contact OSHA's Office of Information and Consumer Affairs at (202) 219-8151 for further assistance in identifying the appropriate contacts.

59 FR 6170, Feb. 9, 1994, as amended at 59 FR 7479, Apr. 13, 1994; 59 FR 65948, Dec. 22, 1994]

§ 1910.1201 Retention of DOT markings, placards and labels.

(a) Any employer who receives a package of hazardous material which is required to be marked, labeled or placarded in accordance with the U. S. Department of Transportation's Hazardous Materials Regulations (49 CFR Parts 171 through 180) shall retain those markings, labels and placards on the package until the packaging is sufficiently cleaned of residue and purged

of vapors to remove any potential hazards.

(b) Any employer who receives a freight container, rail freight car, motor vehicle, or transport vehicle that is required to be marked or placarded in accordance with the Hazardous Materials Regulations shall retain those markings and placards on the freight container, rail freight car, motor vehicle or transport vehicle until the hazardous materials which require the marking or placarding are sufficiently removed to prevent any potential hazards.

(c) Markings, placards and labels shall be maintained in a manner that ensures that they are readily visible.

(d) For non-bulk packages which will not be reshipped, the provisions of this section are met if a label or other acceptable marking is affixed in accordance with the Hazard Communication Standard (29 CFR 1910.1200).

(e) For the purposes of this section, the term "hazardous material" and any other terms not defined in this section have the same definition as in the Hazardous Materials Regulations (49 CFR Parts 171 through 180).

[59 FR 36700, July 19, 1994]

§ 1910.1450 Occupational exposure to hazardous chemicals in laboratories.

(a) *Scope and application.* (1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

(i) For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

(ii) Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

(iii) Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated sub-

stance with exposure monitoring and medical surveillance requirements, paragraphs (d) and (g)(1)(ii) of this section shall apply.

(3) This section shall not apply to:

(i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

(ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

(A) Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

(B) Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

(b) *Definitions—*

Action level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (see *select carcinogen*).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(i) **Flammable** means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(7) **Solid, flammable** means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-79 (ASTM D 93-79))-for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) Setaflash Closed Tester (see American National Standard Method of

employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Combustible liquid means any liquid having a flashpoint at or above 100 °F (37.8 °C), but below 200 °F (93.3 °C), except any mixture having components with flashpoints of 200 °F (93.3 °C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 °F (21.1 °C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 °F (54.4 °C) regardless of the pressure at 70 °F (21.1 °C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 °F (37.8 °C) as determined by ASTM D-323-72.

Designated area means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable means a chemical that falls into one of the following categories:

(i) **Aerosol, flammable** means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) **Gas, flammable** means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) **Liquid, flammable** means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) **Solid, flammable** means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))-for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of

A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of percent by volume or less; or

A liquid that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(i) *Liquid, flammable* means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which is up to 99 percent or more of the total weight of the mixture.

(v) *Solid, flammable* means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is likely to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which may be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical will be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) *Pensky-Martens Closed Tester* (See International Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))—for liquids with a viscosity of less than 45 centipoise Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) *Pensky-Martens Closed Tester* (See American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-99 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) *Setaflash Closed Tester* (see American National Standard Method of

Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term *health hazard* includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided

that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

Liquid, flammable means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) **Solid, flammable** means a solid, other than a blasting agent or explosive as defined in §1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tagliabue Closed Tester, Z11.24-1979 (ASTM D 56-79))—for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) Setafash Closed Tester (see American National Standard Method of

§ 1910.1450

Reproductive toxins means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis)

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m³;

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

(c) **Permissible exposure limits.** For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

(d) **Employee exposure determination—**

(1) **Initial monitoring.** The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure lev-

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els for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

(2) **Periodic monitoring.** If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

(3) **Termination of monitoring.** Monitoring may be terminated in accordance with the relevant standard.

(4) **Employee notification of monitoring results.** The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

(e) **Chemical hygiene plan—General.** (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan.)

(1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

(i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

(ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.

(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:

(i) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hy-

and pressure, forms a flammable mixture with air at a concentration of percent by volume or less; or

A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(b) *Flammable* means any liquid having a flashpoint below 100 °F (38 °C), except any mixture having components with flashpoints of 100 °F (38 °C) or higher, the total of which is up to 99 percent or more of the total mass of the mixture.

(c) *Solid, flammable* means a solid, other than a blasting agent or explosive as defined in §1910.109(a), that is likely to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which will be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical will be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a distance greater than one-tenth of an inch (2.5 mm) second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) *Tagliabue Closed Tester* (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))—for liquids with a viscosity of less than 45 centipoise (Universal Seconds (SUS) at 100 °F (38 °C)), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) *Pensky-Martens Closed Tester* (See American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) *Setaflash Closed Tester* (See American National Standard Method of

giene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous:

(iii) A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

(iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;

(v) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

(vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

(vii) Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee; and

(viii) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

(A) Establishment of a designated area;

(B) Use of containment devices such as fume hoods or glove boxes;

(C) Procedures for safe removal of contaminated waste; and

(D) Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) *Employee information and training.*

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and

prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

(3) *Information.* Employees shall be informed of:

(i) The contents of this standard and its appendices which shall be made available to employees;

(ii) The location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(v) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

(4) *Training.* (i) Employee training shall include:

(A) Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(B) The physical and health hazards of chemicals in the work area; and

(C) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) *Medical consultation and medical examinations.* (1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

mixture with air at a concentration of 12 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) *Liquid, flammable* means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) *Solid, flammable* means a solid, other than a blasting agent or explosive as defined in §1910.109(a), that is capable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))-for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) Setflash Closed Tester (see American National Standard Method of

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(i) Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

(ii) Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

(iii) Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

(2) All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

(3) *Information provided to the physician.* The employer shall provide the following information to the physician:

(i) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(ii) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) *Physician's written opinion.* (i) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(C) Any medical condition which may be revealed in the course of the examination which may place the employee

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at increased risk as a result of exposure to a hazardous chemical found in the workplace; and

(D) A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) *Hazard identification.* (1) With respect to labels and material safety data sheets:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

(2) The following provisions shall apply to chemical substances developed in the laboratory:

(i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

(ii) If the chemical produced is a by-product whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

(i) *Use of respirators.* Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accord-

increased risk as a result of exposure to a hazardous chemical found in workplace; and

(c) A statement that the employee been informed by the physician of results of the consultation or medical examination and any medical condition that may require further examination or treatment.

(d) The written opinion shall not reflect specific findings of diagnoses unrelated to occupational exposure.

(e) **Hazard identification.** (1) With respect to labels and material safety data sheets:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(ii) Employers shall maintain material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

(3) The following provisions shall apply to chemical substances developed in the laboratory:

(i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

(ii) If a chemical produced is a by-product whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labels.

(4) **Use of respirators.** Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance

with the requirements of 29 CFR 1910.134.

(j) **Recordkeeping.** (1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

(k) **Dates—(1) Effective date.** This section shall become effective May 1, 1990.

(2) **Start-up dates.** (i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) **Appendices.** The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

[55 FR 3327, Jan. 31, 1990, 55 FR 7967, Mar. 6, 1990, 55 FR 12111, Mar. 30, 1990]

APPENDIX A TO § 1910.1450—NATIONAL RESEARCH COUNCIL RECOMMENDATIONS CONCERNING CHEMICAL HYGIENE IN LABORATORIES (NON-MANDATORY)

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Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted from "Prudent Practices for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW., Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deals with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical

re and pressure, forms a flammable mixture with air at a concentration of percent by volume or less; or

3) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(ii) **Liquid, flammable** means any liquid having a flashpoint below 100 °F (37.8 °C) except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) **Solid, flammable** means a solid, other than a blasting agent or explosive as defined in §1910.109(a), that is able to cause fire through friction, sorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) **Tagliabue Closed Tester** (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))—for liquids with a viscosity of less than 45 centipoise Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) **Pensky-Martens Closed Tester** (See American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-9 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) **Setaflash Closed Tester** (see American National Standard Method of

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cal hazards. Therefore, only those recommendations directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposures.	D
(e)(3)(iii) Fume hood performance.	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations.	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. *It is prudent to minimize all chemical exposures.* Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2, 10). Skin contact

with chemicals should be avoided as a cardinal rule (198).

2. *Avoid underestimation of risk.* Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).

3. *Provide adequate ventilation.* The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).

4. *Institute a chemical hygiene program.* A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6, 11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).

5. *Observe the PELs, TLVs.* The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. *Chief executive officer*, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. *Supervisor of the department or other administrative unit*, who is responsible for chemical hygiene in that unit (7).

3. *Chemical hygiene officer(s)*, whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);

(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);

(c) See that appropriate audits are maintained (8);

(d) Help project directors develop precautions and adequate facilities (10);

(e) Know the current legal requirements concerning regulated substances (50); and

(f) Seek ways to improve the chemical hygiene program (8, 11).

4. *Laboratory supervisor*, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);

(b) Provide regular, formal chemical hygiene and housekeeping inspections includ-

with chemicals should be avoided as a cardinal rule (198).

2. *Avoid underestimation of risk.* Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).

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5. *Observe the PELs, TLVs.* The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. *Chief executive officer*, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. *Supervisor of the department or other administrative unit*, who is responsible for chemical hygiene in that unit (7).

3. *Chemical hygiene officer(s)*, whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices;

(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);

(c) See that appropriate audits are maintained (8);

(d) Help project directors develop precautions and adequate facilities (10);

(e) Know the current legal requirements concerning regulated substances (50); and

(f) Seek ways to improve the chemical hygiene program (8, 11).

4. *Laboratory supervisor*, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);

(b) Provide regular, formal chemical hygiene and housekeeping inspections includ-

ing routine inspections of emergency equipment (21, 171);

(c) Know the current legal requirements concerning regulated substances (50, 231);

(d) Determine the required levels of protective apparel and equipment (156, 160, 162); and

(e) Ensure that facilities and training for use of any material being ordered are adequate (215).

5. *Project director or director of other specific operation*, who has primary responsibility for chemical hygiene procedures for that operation (7).

6. *Laboratory worker*, who is responsible for:

(a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and

(b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. *Design.* The laboratory facility should have:

(a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);

(b) Adequate, well-ventilated stockrooms/storerooms (218, 219);

(c) Laboratory hoods and sinks (12, 162);

(d) Other safety equipment including eye-wash fountains and drench showers (162, 169); and

(e) Arrangements for waste disposal (12, 240).

2. *Maintenance.* Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continuing appraisal and be modified if inadequate (11, 12).

3. *Usage.* The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).

4. *Ventilation—(a) General laboratory ventilation.* This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).

(b) *Hoods.* A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp.

201-206 for a discussion of hood design, construction, and evaluation.

(c) *Other local ventilation devices.* Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).

(d) *Special ventilation areas.* Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).

(e) *Modifications.* Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).

(f) *Performance.* Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).

(g) *Quality.* General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60-100 fpm) (200, 204).

(h) *Evaluation.* Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp. 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the Chemical Hygiene Plan

1. *Basic Rules and Procedures* (Recommendations for these are given in section E, below)

2. *Chemical Procurement, Distribution, and Storage*

(a) *Procurement.* Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (215, 216). No container should be accepted without an adequate identifying label (216). Preferably, all substances should be received in a central location (216).

(b) *Stockrooms/storerooms.* Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for

pressure, forms a range of mixtures with air wider percent by volume, regardless of limit.

Flammable means any liquid having a flashpoint below 100 °F except any mixture having flashpoints of 100 °F or more of the total mixture.

Flammable means a solid, a blasting agent or explosive in §1910.109(a), that is cause fire through friction, of moisture, spontaneous change, or retained heat from ring or processing, or which is readily and when ignited vigorously and persistently as a serious hazard. A chemical considered to be a flammable is tested by the method described in 16 CFR 1500.44, it ignites and a self-sustained flame at a rate of one-tenth of an inch along its major axis.

Flash point means the minimum temperature at which a liquid gives off a sufficient concentration to ignite as follows:

Abuse Closed Tester (See National Standard Method of Flash Point by Tag Closed 1.24-1979 (ASTM D 56-79)) for a viscosity of less than 45 Universal Seconds (SUS) at 100 °C, that do not contain solids and do not have a tendency to form a surface film under test;

Artens Closed Tester (See National Standard Method of Flash Point by Artens Closed Tester, Z11.7-1 D 93-79)) for liquids with a flash point equal to or greater than 45 °F (37.8 °C), or that contain solids, or that have a tendency to form a surface film under test;

Flash Closed Tester (see National Standard Method of

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replacement, deterioration, and container integrity (218-19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) *Distribution*. When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) *Laboratory storage*. Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) *Cleaning*. Floors should be cleaned regularly (24).

(b) *Inspections*. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for others; informal inspections should be continual (21).

(c) *Maintenance*. Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Safety showers should be tested routinely (169). Other safety equipment should be inspected regularly (e.g., every 3-6 months) (6, 24, 171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) *Passageways*. Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) *Compliance with regulations*. Regular medical surveillance should be established to the extent required by regulations (12).

(b) *Routine surveillance*. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) *First aid*. Personnel trained in first aid should be available during working hours

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and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substances being handled (158-161);

(b) An easily accessible drench-type safety shower (162, 169);

(c) An eyewash fountain (162);

(d) A fire extinguisher (162-164);

(e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and

(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).

(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).

(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.

(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);

(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);

(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and

(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).

(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).

(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

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(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).

(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).

Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).

Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).

(d) Frequency of Training: The training and education program should be a regular, continuing activity—not simply an annual presentation (15).

(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program.

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).

(b) Content (14, 232, 233, 240): The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27).

Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).

Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or add-

ing them to mixed refuse for landfill burial is unacceptable (14).

Hoods should not be used as a means of disposal for volatile chemicals (40, 200).

Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1. General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) *Accidents and spills—Eye Contact:* Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).

Ingestion: Encourage the victim to drink large amounts of water (178).

Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).

Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24 33). See pp. 233-237 for specific clean-up recommendations.

(b) *Avoidance of "routine" exposure:* Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23);

Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).

Inspect gloves (157) and test glove boxes (208) before use.

Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

(c) *Choice of chemicals:* Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) *Eating, smoking, etc.:* Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24).

Avoid storage, handling or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e) *Equipment and glassware:* Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (25). Use extra care with Dewar flasks and

flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) *Liquid, flammable* means any liquid having a flashpoint below 100 °F (38 °C), except any mixture having components with flashpoints of 100 °F (38 °C) or higher, the total of which accounts for 10 percent or more of the total volume of the mixture.

(iv) *Solid, flammable* means a solid, other than a blasting agent or explosive as defined in §1910.109(a), that is liable to cause fire through friction, sorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))—for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) Setflash Closed Tester (see American National Standard Method of

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other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) *Exiting*: Wash areas of exposed skin well before leaving the laboratory (23).

(g) *Horseplay*: Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(h) *Mouth suction*: Do not use mouth suction for pipeting or starting a siphon (23, 32).

(i) *Personal apparel*: Confine long hair and loose clothing (23, 158). Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) *Personal housekeeping*: Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) *Personal protection*: Assume that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).

Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).

Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169).

Use any other protective and emergency apparel and equipment as appropriate (22, 157-162).

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).

Remove laboratory coats immediately on significant contamination (161).

(l) *Planning*: Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) *Unattended operations*: Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) *Use of hood*: Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).

As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13).

Confirm adequate hood performance before use: keep hood closed at all times except when adjustments within the hood are being

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made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).

Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

(o) *Vigilance*: Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) *Waste disposal*: Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).

Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

(q) *Working alone*: Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) *Allergens* (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) *Embryotoxins* (34-5) (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.

Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.

Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.

Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

EXAMPLES: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).

Supplemental rules to be followed in addition to those mentioned above (Procedure B of "Prudent Practices", pp. 39-41):

(a) *Aim*: To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

... percent by volume. ...
... lower limit.

Liquid, flammable means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which is up to 99 percent or more of the total mass of the mixture.

Solid, flammable means a solid, or a blasting agent or explosive as defined in §1910.109(a), that is able to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which is readily ignited and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical will be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) **Tagliabue Closed Tester** (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))—for liquids with a viscosity of less than 45 centipoise Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

(ii) **Pensky-Martens Closed Tester** (See American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

(iii) **Setaflash Closed Tester** (see American National Standard Method of

(b) **Applicability:** These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) **Location:** Use and store these substances only in areas of restricted access with special warning signs (40, 229).

Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to prevent their discharge with the hood exhaust (40).

(d) **Personal protection:** Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).

(e) **Records:** Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) **Prevention of spills and accidents:** Be prepared for accidents and spills (41).

Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).

Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40).

If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) **Waste:** Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).

Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances with high carcinogenic potency in animals (38).)

Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47-50).

(a) **Access:** Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly

toxic substances, for which all people with access are aware of the substances being used and necessary precautions (48).

(b) **Approvals:** Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) **Non-contamination/Decontamination:** Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50).

Decontaminate the controlled area before normal work is resumed there (50).

(d) **Exiting:** On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).

(e) **Housekeeping:** Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).

(f) **Medical surveillance:** If using toxicologically significant quantities of such a substance on a regular basis (e.g., 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) **Records:** Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) **Signs and labels:** Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).

(i) **Spills:** Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).

(j) **Storage:** Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).

(k) **Glove boxes:** For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood (49).

(l) **Waste:** Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

re and pressure, forms a flammable mixture with air at a concentration of percent by volume or less; or

B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

iii) *Liquid, flammable* means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

iv) *Solid, flammable* means a solid, other than a blasting agent or explosive as defined in §1910.109(a), that is liable to cause fire through friction, sorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))—for liquids with a viscosity of less than 45 centipoise Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test;

ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-79 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test;

iii) Setaflash Closed Tester (see American National Standard Method of

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5. Animal Work with Chemicals of High Chronic Toxicity

(a) *Access:* For large scale studies, special facilities with restricted access are preferable (56).

(b) *Administration of the toxic substance:* When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).

(c) *Aerosol suppression:* Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).

(d) *Personal protection:* When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).

(e) *Waste disposal:* Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise, package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)
2. Electrically powered laboratory apparatus: (179-92)
3. Fires, explosions: (26, 57-74, 162-4, 174-5, 219-20, 226-7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

- *Acetyl peroxide (105)
- *Acrolein (106)
- *Acrylonitrile (107)

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- Ammonia (anhydrous) (91)
- *Aniline (109)
- *Benzene (110)
- *Benzo[a]pyrene (112)
- *Bis(chloromethyl) ether (113)
- Boron trichloride (91)
- Boron trifluoride (92)
- Bromine (114)
- *Tert-butyl hydroperoxide (148)
- *Carbon disulfide (116)
- Carbon monoxide (92)
- *Carbon tetrachloride (118)
- *Chlorine (119)
- Chlorine trifluoride (94)
- *Chloroform (121)
- Chloromethane (93)
- *Diethyl ether (122)
- Diisopropyl fluorophosphate (41)
- *Dimethylformamide (123)
- *Dimethyl sulfate (125)
- *Dioxane (126)
- *Ethylene dibromide (128)
- *Fluorine (95)
- *Formaldehyde (130)
- *Hydrazine and salts (132)
- Hydrofluoric acid (43)
- Hydrogen bromide (98)
- Hydrogen chloride (98)
- *Hydrogen cyanide (133)
- *Hydrogen sulfide (135)
- Mercury and compounds (52)
- *Methanol (137)
- *Morpholine (138)
- *Nickel carbonyl (99)
- *Nitrobenzene (139)
- Nitrogen dioxide (100)
- N-nitrosodiethylamine (54)
- *Peracetic acid (141)
- *Phenol (142)
- *Phosgene (143)
- *Pyridine (144)
- *Sodium azide (145)
- *Sodium cyanide (147)
- Sulfur dioxide (101)
- *Trichloroethylene (149)
- *Vinyl chloride (150)

APPENDIX B TO §1910.1450—REFERENCES (NON-MANDATORY)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory. (a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.
2. Fawcett, H.H. and W. S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.

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3-REFERENCES (NON-
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a) Materials for the
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Society, Safety in
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W. S. Wood, Safety
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3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.
4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.
5. Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.
6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.
8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1981.
9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III 1974.
11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7 Cincinnati, OH 45211-4438 (latest edition).
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.
4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z, U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards, NIOSH Pub. No. 85-114, U.S. Gov-

ernment Printing Office, Washington, DC, 1985 (or latest edition).

9. Occupational Health Guidelines, NIOSH/OSHA NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes)
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of Documents U.S. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs, Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications, Park Ridge, NJ, 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.
- Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.
- Fire Protection Guide on Hazardous Materials, 7th edition, 1978.
- National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LFT-1980, 1101 16th Street, NW., Washington, DC 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

(Approved by the Office of Management and Budget under control number 1218-0131)

[55 FR 3327, Jan. 31, 1990; 55 FR 7967, Mar. 6, 1990; 57 FR 29204, July 1, 1992]

§ 1910.1499 Source of standards.

Section 1910.1000 41 CFR 50-204.50, except for Table Z-2, the source of which is American National Standards Institute, Z37 series.

[40 FR 23073, May 28, 1975]

§ 1910.1500 Standards organizations.

Specific standards of the following organizations have been referred to in

this subpart. Copies of the standards may be obtained from the issuing organization.

American Conference of Governmental Industrial Hygienists
6500 Glenway Avenue, Bldg. D-7
Cincinnati, Ohio 45211-4438
American National Standards Institute
1430 Broadway
New York, New York 10018

[40 FR 23073, May 28, 1975, as amended at 43 FR 57603, Dec. 8, 1978; 57 FR 29204, July 1, 1992]

ture and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(ii) *Liquid, flammable* means any liquid having a flashpoint below 100 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) *Solid, flammable* means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

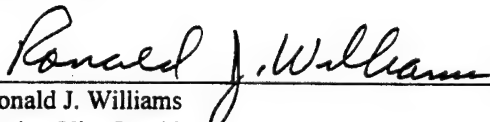
(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))-for liquids with a viscosity equal to or greater than 45 SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setarflash Closed Tester (see American National Standard Method of

Respiratory Protection Plan for
TVA's Environmental Research Center
Revision 1
September 30, 1995

Approved by:



Ronald J. Williams
Acting Vice President
Environmental Research Center

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INTRODUCTION

The use of respiratory protective equipment is required to ensure the safety and health for those employees at TVA'S Environmental Research Center engaged in operations where contaminants cannot be engineered out of the work environment. Contaminants can be encountered by the failure of control equipment or when adequate work practices are not utilized. Contaminants vary in form from nuisance dust to vapors, particulate matter, gases, mists, fumes, and fogs. These Respiratory Protection Program guidelines are written to establish and provide guidelines for the proper use of respirators at the Center's facilities. They should also be used to develop detailed Standard Operating Procedures (SOP's) where needed.

These guidelines are based on the following: OSHA Respirator Requirements 29 CFR 1910.134, OSHA Respiratory Compliance Section of the Industrial Hygiene Field Operations Manual (March 2, 1981), American National Standards Institute Z88.2-1969 and 1980, "A Guide to Industrial Respiratory Protection," September 1987, HHS Pub. No. (NIOSH 87-116), and Manual of Respiratory Protection Against Airborne Radioactive Materials (NUREG - 0041, September 1976).

AGENCY POINT OF CONTACT

The TVA Agency contact for information regarding respiratory protection is the Manager of Safety, Multipurpose Building, Muscle Shoals, Alabama 35660, (205) 386-2314.

1.0 PURPOSE:

The purpose of these guidelines is to establish the requirements and responsibilities of the elements of a respirator program for research activities and those activities conducted in support of research at the Center.

2.0 SCOPE:

2.1 These guidelines provide broad direction for the planned use of respiratory equipment to protect individuals from exposures to airborne materials that might be encountered during certain operations.

2.2 Guidance is primarily directed to the use of respirators to prevent the inhalation of airborne materials.

2.3 These guidelines are applicable to employees, inspectors, and visitors, who must enter an area where the use of respiratory protective equipment is required.

2.4 This document does not apply to the use of self-contained breathing apparatus or to the hazards associated with welding.

3.0 OSHA REQUIREMENTS:

3.1 The OSHA General Industry Standard for Respiratory Protection, 29 CFR 1910.134, requires that a respiratory protection program be established by the employer, and that respirators be provided and be effective when such equipment is necessary to protect the health of the employee.

3.2 Respiratory protection against airborne radioactive materials may require additional compliance as listed in U.S. Nuclear Regulatory Commission requirements (10 CFR 20).

3.3 **CARCINOGENS:** Since the National Institute for Occupational Safety and Health (NIOSH) maintains that there is no safe exposure to carcinogens; unless otherwise authorized, only the most protective respirators should be used to protect workers from exposure to carcinogens in the workplace. OSHA standards on specific carcinogens list required respiratory protection.

4.0 RESPONSIBILITIES:

4.1 The employee - It is the responsibility of each employee to use respiratory protective equipment according to the requirements of the Respiratory Protection Program Guidelines.

4.2 The employer - Current Federal regulations assign the employer the responsibility to provide safe and healthful working conditions for workers. Where engineering and/or administrative controls have failed to eliminate hazardous or potentially hazardous conditions, or the utilization of such controls is not feasible and respirators are necessary to protect the health of the employee, then respirators shall be provided by the employer.

5.0 GENERAL REQUIREMENTS (minimal acceptable program):

5.1 Only approved respirators shall be used. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with established standards. The Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (MSHA-NIOSH) are responsible for testing and certifying respirators.

5.2 Respirators shall be selected on the basis of hazards to which the employee is exposed.

- 5.3 The employee shall be instructed and trained in the proper use of respirators and their limitations.
- 5.4 Respirators shall be regularly cleaned and disinfected by the user. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.
- 5.4 Respirators shall be stored in a convenient, clean, and sanitary location.
- 5.5 Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced.
- 5.6 Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained by the supervisor.
- 5.7 There shall be regular inspection and evaluation to determine the continued effectiveness of the program by the supervisor.
- 5.8 Employees shall not be assigned to tasks requiring use of respirators unless it has been determined by means of a medical examination that they are physically able to perform the work and use the equipment.
- 5.9 Employees shall be properly trained in the use of respirators. Such training shall be reviewed on an annual basis and shall include the following elements:
- 5.9.1 The nature, extent, and effects of the respiratory hazard to which the employee may be exposed and the need for respiratory protection.
 - 5.9.2 Engineering or work practice controls to be used during the operation.
 - 5.9.3 Respirator selection to match a specific hazard, capabilities and limitations of respirators, and maintenance of respirators.
 - 5.9.4 Inspection, donning, checking the fit of, and wearing respirators, and instructions for special use of respirators.
 - 5.9.5 Recognizing and handling emergency respiratory hazard situations.
 - 5.9.6 Criteria for changing filter elements for air-purifying respirators. (e.g. When breathing becomes difficult or when the employee can smell or taste the contaminants).
 - 5.9.7 Regulations on respirator use and the contents of this Respiratory Protection Guideline.
- 5.10 Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be the growth of a beard or sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses.
- 5.11 The wearing of contact lenses in contaminated atmospheres with a respirator shall not be allowed.
- 5.12 Employees shall be provided a fit test to demonstrate that a good face seal exists before being approved to use a respirator.

6.0 SPECIFIC REQUIREMENTS FOR TVA'S ENVIRONMENTAL RESEARCH CENTER

- 6.1 Fume hoods shall be used to prevent atmospheric contamination of laboratory breathing air. This primary engineering control measure shall be used to enclose or confine any potentially unsafe working

operation. Employees shall use fume hoods for any work where the breathing air may be contaminated with harmful dusts, fogs, fumes, mists, gases, or vapors.

6.2 Substitution of less toxic materials will be employed when possible to minimize any respiratory or other hazardous risk.

6.3 When engineering controls are not completely effective, respirators as described below can be used as a precautionary measure.

6.3.1 A half-mask respirator or full-face piece respirator can be obtained from the work area supervisor when working with toxic or fuming compounds. Selection of the type respirator shall be made with consideration given to exposure of the eyes. Organic vapor cartridges are used in the respirator when working with toxic organic and volatile organic compounds. Acid gases-organic vapor cartridges are used in the respirator when working with volatile acid, fuming acid, or acid cleaning solutions.

6.3.2 A face piece particle (dust) mask can be obtained from the work area supervisor when working in a dusty or particle-laden atmosphere, and when performing any grinding or sanding operations.

6.4 Instruction and demonstration on the correct selection and usage of respirators shall be provided once annually at a regularly-scheduled safety meeting by a trained industrial hygienist. The industrial hygienist will also provide any additional training as requested.

6.5 Face-piece respirators shall be cleaned using a solution of warm soapy water. Respirators shall be sanitized by immersing in or washing with a one percent sodium hypochlorite solution. Respirators shall be thoroughly rinsed with warm water following cleaning or sanitizing to remove any residues which might hasten deterioration.

6.6 After air drying, face piece respirators shall be stored in a "zip-locking" plastic bag to retard deterioration of rubber parts and assure longer usable life of the cartridges. The employee's name should be clearly printed on the plastic bag.

7.0 REFERENCES

7.1 Code of Federal Regulations, Title 29, Part 1910, Section 134, revised July 1, 1986.

Revision Log for Revision 1

A. Changed title and telephone number for Agency Point of Contact.

Respiratory Protection Plan for Research Activities

A written Respiratory Protection Plan is required by federal law when respirators are being used in the workplace. The attached document is the first revision of the Respiratory Protection Plan for TVA's Environmental Research Center. The plan was initially issued in October 1994. The document was reviewed by a committee consisting of the Chemical Hygiene Officers (CHO's) for the Center: Liz Bailey, Sheryl Cannon, Tim Holt, Robert Johnson, and Bill Rogers.

The CHO's serve the Center because of the Laboratory Standard promulgated by the Occupational Health and Safety Administration. The Laboratory Standard applies only to laboratory use of hazardous chemicals. It is neither a complete safety program nor a complete respiratory protection program. However, since safety and respiratory protection are associated with the Laboratory Standard, the CHO's seemed to be a logical group to review the existing respiratory protection program.

The Respiratory Protection Plan was written only for the Center. It is therefore somewhat limited in scope. While half-mask respirators, full-face respirators, and dust masks are covered, self-contained breathing apparatus and emergency escape devices were deliberately excluded from the document. Only activities expected to occur during research or support of research were considered in writing the document. Welding, similar industrial activities, or chemical plant production activities were not included. What has resulted is a document which is closely allied to the Chemical Hygiene Plan. It should be distributed and filed with your copy of the Chemical Hygiene Plan.

Should any employee see the need for a more extensive program, the Chemical Hygiene Officers should be contacted.

William J. Rogers

**A-14.2 ATTACHMENT: Minimum Safety and Security Requirements for Contractors at Milan
Army Ammunition Plant, Milan, Tennessee**

Spec
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MARTIN MARIETTA

MARTIN MARIETTA ORDNANCE SYSTEMS, INC.

MILAN ARMY AMMUNITION PLANT
MILAN, TENNESSEE 38368
TELEPHONE (901) 686-6101

**MINIMUM SAFETY AND SECURITY REQUIREMENTS FOR CONTRACTORS
AT MILAN ARMY AMMUNITION PLANT, MILAN, TENNESSEE**

Revised 4/95

1. Each employee shall be provided with initial indoctrination and such continuing instruction as will enable him to conduct his work in a safe manner. This indoctrination shall include the provisions of this document.
2. All personnel and vehicles entering MAAP are subject to searches.
3. All persons driving automobiles within the Plant will be required to have a valid State Driver's License, a Plant Pass, and Liability Insurance.
4. Automobiles must be equipped with headlights, taillights, seat belts, stop and turn signals, windshield wipers, and adequate brakes.
5. All vehicles entering a restricted (limited) area must be equipped with an approved fire extinguisher (minimum 2 1/2 lb. BC). Fire extinguishers are also required on gasoline and battery powered generators, materials handling, and similar equipment.
6. The wearing of seat belts by operators and occupants of vehicles is a condition of entry to Milan Army Ammunition Plant.
7. "Strike Anywhere" matches, alcoholic beverages, and narcotics are not allowed within the Plant. Persons under the influence of alcohol or narcotics will not be permitted to enter MAAP.
8. Smoking is permitted only in designated locations and safety matches and cigarette lighters are allowed only outside "restricted areas".
9. Heat, flame, or spark producing equipment will not be permitted inside "restricted areas" without a written permit from the MMOS Safety Department. One copy of the permit must be posted at the work location. *GROUND WIRE INST.*
10. Cameras and video equipment are prohibited within the Plant unless a camera pass is obtained from the Guard Department. A permit (MM-60) must be obtained from the MMOS Safety Department prior to using cameras and video equipment within restricted areas. This permit is in addition to the camera pass.
11. Visitations to other than assigned areas or buildings will not be allowed.
12. A person(s) involved in any vehicle accident within the Plant must report the incident to the Guard Department (phone 6565) immediately. Accidents involving damages to Government (Plant) property must also be reported to the MMOS Safety Department.

12. The following speed limits within the Plant are applicable:

Plant routes Outside Restricted Areas	- 45 mph
Storage Areas	- 35 mph
Operating Lines	- 15 mph
Area J	- 20 mph
Area Q	- 20 mph
Others	- As Posted

13. Line and Area sirens are subject to sounding at any time. When the siren sounds, all persons must proceed immediately to the designated assembly point. This assembly point can be found by following the posted evacuation routes. If you are within an operating line with a vehicle, do not drive the vehicle to the assembly point. Park the vehicle and proceed rapidly to the assembly point by foot. *Boiler house*
14. First Aid Kits must be available at the project site. A person trained in first aid must be present on each project site.
15. Plant ambulance service will be provided to the local hospital for employees sustaining serious injuries. In case of an emergency, dial 17 and give name and location.
- Note: Charges for ambulance services will be billed to the Contractor requesting service.
16. Personal protective equipment applicable to the work shall be furnished as required and its use enforced. Safety glasses are required in all industrial areas of the plant. Face shields and goggles may also be required, depending on the job.
17. Contamination or pollution of any river, stream or water system is prohibited. Spills of hazardous waste/materials must be reported via phone immediately to the Installation On-Scene Coordinator (IOSC) (phone 6776), Guard Dispatcher (phone 6565), or the Environmental Department (phone 6727).
18. All electrical equipment shall be properly grounded to dissipate stray currents. Ground fault circuit interrupters are required when using extension cords.
19. Hand tools and power tools must be in good condition and conform to the established standards for safe operations.
20. Job sites are subject to safety inspections by Plant Safety Personnel, Federal, State, and other regulatory agencies.
21. Good housekeeping must be maintained within the project area.
22. Safety meetings must be held at least once per week.
23. During clearing, excavation, or while performing normal duties at job site(s), if ammunition or ammunition components are found, DO NOT DISTURB THESE ITEMS. Contact MMOS Safety Department immediately (phone 6482 or 6973).

24. Asbestos and materials containing asbestos were used extensively in the construction of facilities throughout Milan AAP. Asbestos may be encountered in insulation for pipes, boilers, water tanks, and in roofing and siding materials (Transite). To insure that no one is exposed to friable asbestos fibers, the presence/absence of asbestos must be verified prior to performing any repairs, maintenance, demolition, or removal. If sampling/testing proves the material to be asbestos, then removal, handling, and disposal must be in accordance with OSHA 1910.1101 and other regulations as applicable.

BURN Permit

Michael E. Harris
Michael E. Harris - Engineering Director
MARTIN MARIETTA ORDNANCE SYSTEMS, INC.
a Lockheed Martin Company

A-14.3 ATTACHMENT: First Aid Instructions for TVA Employees

FIRST-AID INSTRUCTIONS

**For
TVA Employees**

TENNESSEE VALLEY AUTHORITY

Division of Medical Services

1986

TVA/OCS/MS-86/1

Introduction

The instructions in this booklet have been developed to assist TVA employees in using first-aid measures safely and confidently, and to furnish them with specific information regarding the use of supplies available in TVA first-aid kits and first-aid rooms.

This material is not intended as a first-aid text, nor is it a substitute for first-aid training. It is a composite of simple procedures for handling some of the more common injuries and ailments encountered both on and off the job. Employees are encouraged to participate in first-aid training courses offered by TVA and to hold up-to-date first-aid certificates.

All first-aid treatment of injuries on the job, regardless of severity, must be reported according to the procedure described in the TVA Instruction under VIII INJURY, Employee.

First-aid kits, supplies, and refills for locations where there are medical offices or health stations (except Chattanooga) may be obtained on TVA form 9275 submitted to the local medical office or health station. At other locations, and at Chattanooga, storeroom requisitions (forms 9275) should be sent to the Medical Director.

Supplies for refills for first-aid kits also are available at project medical offices, steam plant health stations, and certain district and division offices of the Office of Power.

REMEMBER THAT THE OBJECT OF FIRST AID IS TO MAKE THE PERSON MORE COMFORTABLE AND TO REDUCE THE CHANCE OF FURTHER INJURY OR DISABILITY. WHEN IN DOUBT ALWAYS REFER TO A PHYSICIAN.

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ABRASIONS AND SCRATCHES

Wash gently but thoroughly with soap and water.
 Rinse with clean water.
 Remove obvious foreign particles from the wound.
 Apply antiseptic.
 Apply sterile dressing.

ACUTE ILLNESS

Headache, cough, chills, dizziness, nausea, vomiting, sore throat, or fever may be forerunners of a communicable or severe disease. They may also accompany exposures to various poisonous materials. If these symptoms are severe enough to cause complaint, medical advice should be sought. Other workers should be protected from exposure by isolating the sick worker until he can be seen by a physician.

AMPUTATION

In case of partial or complete amputation every effort should be made to preserve the severed part. Hold it in position with a sterile compress and support with splint.

Control bleeding as quickly as possible.

Use a sterile compress to help control bleeding.

Use a tourniquet only if direct pressure and all other procedures to control bleeding fail.

Place a sterile dressing over all injured tissue.

Treat injured person for shock (See p. 13.)

Refer to physician immediately.

ANIMAL BITES (INCLUDES BAT BITES)

Wash wound with soap and water to remove animal saliva.

Rinse well.

Apply sterile dressing.

Refer to physician.

Notify local health department.

Caution:

It is not necessary to kill domestic pets suspected of having rabies, except to protect others from danger. Such pets should be confined and observed for 10 days for such signs of rabies as changed behavior, excitability, salivation, paralysis, and death. Wild animals may not show clear signs of rabies and
(Continued)

should be killed for examination.

If you have to kill a suspected animal, try not to damage its head.

If you are bitten by an animal, always suspect it to be rabid until proved otherwise.

ASPHYXIA (STOPPAGE OF BREATHING)

Common Cause:

Obstruction of air passage to lungs as in choking, drowning, etc.

Paralysis of the respiratory center of brain as in electric shock.

Interference with the oxygen-carrying function of red blood corpuscles as in carbon monoxide asphyxiation.

Lack of oxygen in air breathed as in storage bins, mines, etc.

Treatment:

Be sure person is in fresh air.

Start artificial respiration immediately. Follow instructions on pages 17-18.

Treat for shock. (See p. 13.)

Call for help at once.

BRUISES

A bruise is usually caused by a blow or fall. The skin is not broken but the tissues underneath are injured, resulting in broken small blood vessels. Pain, swelling, and black and blue colors appear.

Treatment:

Immediately apply cloths wrung out in cold water or an icebag. If possible, elevate the injured part and place it at complete rest.

The general rule is "cold" applications for the first 24 hours followed by "heat."

If soreness or disability persists, refer patient to physician.

BURNS AND SCALDS

FIRST and SECOND DEGREE THERMAL BURN

Immerse burned area in a container of cold water, preferably 45-50° F. If the part cannot be immersed, apply cloths soaked in ice water and change the cold packs constantly.

Continue cold-water treatment until patient can stand removal without recurrence of pain.

Do not break blisters intentionally.

Treat the person for shock (see page 13.) (Continued)

After cold-water treatment, cover burn area with sterile dressing.

Refer patient to physician.

THIRD DEGREE THERMAL BURN

Cover with dry sterile dressing.

Treat for shock (see page 13.)

Leave blisters alone.

Refer to physician.

CHEMICAL BURNS: (Acid or Alkali)

Flush burned area at least 15 minutes with large quantities of water (preferably lukewarm).

Cover with sterile dressing.

Refer patient to physician if burns are severe or extensive.

CRESOTE BURNS:

Use cresote burn wash found in TVA first-aid kits.

ELECTRIC BURNS:

Should always be treated as severe burns, unless clearly of a minor nature.

EYE BURNS: (See page 7.)

SUNBURN:

Same treatment as for minor burn, if small area involved.

Severe or extensive cases should be referred to a physician.

CARBON MONOXIDE POISONING

Remove victim to fresh air.

If breathing has stopped or comes in gasps, start artificial respiration (see page 17) and continue until natural breathing is restored or until the doctor pronounces person dead.

Keep victim warm and insist on complete rest until he is seen by a physician. Even slight exercise is dangerous.

Refer to a physician.

CHEST AND ABDOMINAL INJURIES

Blows to the chest and abdomen may result in injury to underlying organs and tissues, even though no sign of injury may be seen.

(Continued)

Treatment:

Keep patient warm and quiet.

Do not move until transportation is arranged.

Cover open wounds with sterile dressings.

In case of suspected abdominal injury give nothing by mouth.

Refer to a physician.

CHOKING

If the victim is breathing well with only partial obstruction and is still able to speak or cough effectively, do not interfere with his attempts to expel a foreign body. If the victim cannot speak or cough, uses a distress signal, appears blue, or shows an exaggerated effort to breathe, you must follow the procedures described below.

SITTING OR STANDING VICTIM

Stand behind the victim and wrap your arms around his waist. Place the thumb side of your fist against the victim's abdomen, slightly above the navel and below the xiphoid process (tip of the breastbone). Grasp your fist with your other hand and press it into the victim's abdomen with four quick upward thrusts.

SUPINE VICTIM

Place one of your hands on top of the other, with the heel of the bottom hand in the middle of the victim's abdomen, slightly above the navel and below the rib cage. Move forward so that your shoulders are directly over the victim's abdomen and press upward toward the diaphragm with four quick thrusts. Do not press to either side.

COLD INJURY

CHILBLAIN

Prevention

Keep feet warm and dry.

Avoid standing for a long time without exercise.

Treatment

Immerse in warm, not hot, water.

Treat as a minor burn.

(Continued)

"TRENCH" FOOT:

After hours of exposure to low (but not freezing) temperature, feet become very painful. Swelling and numbness follow.

Treatment:

Keep patient off his feet. Use a stretcher to carry him to a physician.

Cover foot (or feet) with sterile dressing.

Do not allow victim to smoke.

FROST BITE:

Signs of frostbite are whiteness and numbness of the flesh; the skin feels cold to the touch.

Treatment:

For small areas such as the nose, ears, and other parts of the face, place warm palm of hand over area, but do not rub.

Frostbitten fingers: Warm directly against skin in armpit.

Frostbitten feet: Immerse in warm (but NOT hot) water.

Encourage gentle exercise of fingers and toes.

Don't expose to high temperature immediately.

Give victim a warm drink.

Handle frozen part with great care to avoid injury to it.

Refer to physician if injury is severe or extensive.

COMMUNICABLE DISEASES

Communicable diseases are most catching in the early stages, even before rash and other signs appear. Therefore, if a worker knows he has been exposed to a communicable disease, he should take personal responsibility not to spread it. He should consult a physician immediately upon the onset of such warning signs as cough, sore throat, aching in joints and muscles, unusual tiredness, and the like.

CONVULSIVE SEIZURE (EPILEPSY)

Insert, but do not force, a small piece of wood well wrapped with gauze or clean cloth between patient's teeth to keep him from biting his tongue.

Do not attempt to hold patient still. Protect him from injury as he thrashes about.

Give nothing by mouth.

Refer to physician.

DERMATITIS (SKIN RASH)

Some skin diseases may be caused by things individuals come in contact with either on the job or elsewhere. Preventing contact with materials to which one is sensitive will help control skin rashes.

Prevention:

- Use engineering safeguards and protective clothing which have been recommended.
- Practice good housekeeping in your work area.
- Keep clean—personal cleanliness is the most important single factor in control of contact dermatitis.
- Dry hands well after washing.
- Do not use kerosene, gasoline, or carbon tetrachloride or other similar solvents for cleansing skin.
- Ointments and lotions may aggravate dermatitis unless such treatment is prescribed for specific conditions.
- Remove contaminated clothing as soon as possible.

Treatment

- Refer to physician.

DIABETIC EMERGENCIES

Unconsciousness is sometimes a complication in the person with diabetes. This may be of two types—one due to the disease and the other due to temporary accumulation in the body of too much insulin which has been used in the control of the disease.

In either case, the unconscious diabetic should be seen by a physician without delay.

Every diabetic should carry an identification card and should inform at least one of his fellow employees of his disease. Diabetics often complicate the healing of wounds. Injuries to the feet are especially troublesome and should be treated by a physician. All other injuries should be treated by a physician if healing does not take place promptly.

DISLOCATIONS

The injured joint looks out of shape when compared with a similar joint, and there is pain and usually swelling. Many dislocations are also accompanied by broken bones.

(Continued)

Treatment:

- Do not attempt to put a dislocation back in place.
- Support dislocations in a comfortable manner.
- Treat for shock if necessary (See page 13.)
- Refer to physician.

DROWNING

Make certain that air passages are not blocked.

Start artificial respiration at once, check for circulation, and continue resuscitation as needed until physician declares there is no further need, or until you become exhausted. (See pages 17 & 18.)

Treat for shock.

Send for physician.

When breathing is restored make sure he receives medical attention by a physician.

EYES

CHEMICAL BURNS: (Acid or Alkali)

Treatment:

Wash the eye freely with clean water. This may be done by immersing the face in pan or bowl of water, gently pulling back the lids, and moving the eye back and forth. Another way is to place the person on his back, hold his eyelids open with your fingers, and pour water into the inner corner of the eye from a pitcher or other container.

Continue this for at least 15 minutes.

Apply eye patch.

Refer to physician as soon as possible.

Caution:

When work is being done in which there is a possibility of chemical burn, be sure there is plenty of clean water available.

FOREIGN BODY:

On Surface of the Eyeball:

Do not try to remove.

Refer to physician.

On Surface of the Membrane Lining the Eyelid:

Pull the lower lid down gently and look for the speck.

(Continued)

Remove it with a corner of clean piece of gauze or a twist of cotton moistened with water.

If speck seems to be on the lining of the upper eyelid, grasp the lashes of the upper lid gently and draw the upper lid down over the lower lid. As the upper lid returns to its normal position, the foreign body may be caught on the lashes of the lower lid and removed by washing action.

If these measures fail, refer to a physician.

EYE INJURIES:

If the eye is injured by a foreign body — like a splinter of glass, metal, or wood, or by a particle blown into it with great force — apply eye patch.

If there is a protruding foreign body, do not remove it but bandage both eyes, using great caution so that the foreign body is not driven into the eyeball.

If the eyelids and tissue around them are injured, apply a firm bandage to prevent movement of the lids.

Refer to a physician.

FAINING

Prevention

If a person says he feels as if he will faint, have him sit down and bend his body forward until his head is level with his knees. He should hold this position for a few minutes or lie down.

Treatment:

Place person on back with head lower than body.

Supply cool air.

Loosen clothing around neck and waist.

After consciousness returns, person should continue to lie quiet for a while before getting up.

If the faint lasts more than a few minutes the person should be referred to a physician.

FRACTURE (BROKEN BONES)

ACTUAL OR SUSPECTED FRACTURE:

Gentleness is more important than speed in handling the patient.

Keep injured part at rest by splinting and bandaging.

Keep person warm and quiet.

Refer to physician.

COMPOUND FRACTURE:

If the bone shows through the skin, cover injured part with a sterile dressing. Control bleeding if present.

Do not disturb position of injured part. Splint.

Treat for shock (See page 13.)

Refer to physician.

HEAD INJURY

Treatment:

Keep the person lying down.

Do not move the victim's head unless airway maintenance is necessary.

Treat any bleeding wound. (Bleeding from ears or nose may indicate serious injury. Do not attempt to treat.)

Keep patient warm and quiet.

Give nothing by mouth.

Refer to physician.

Caution:

If blow on head is hard enough to cause even momentary unconsciousness, refer to physician.

HEAT CRAMPS

Same treatment and preventive measures as for heat exhaustion (see below).

HEAT EXHAUSTION

This condition may occur during long heat waves or in locations where heavy work is done in high temperatures. The victim may show signs of shock and usually is conscious, pale, and cool.

Prevention:

Drink water often throughout the day, 1 glass at a time.

Wear working clothes that are light and porous to promote evaporation of perspiration.

(Continued)

Treatment:

- Have person lie down in cool place with head lowered.
- Loosen his clothing.
- Cover body with light covering.
- If he is conscious give cool water.
- Refer to physician if symptoms do not disappear quickly.

HEAT STROKE OR SUN STROKE

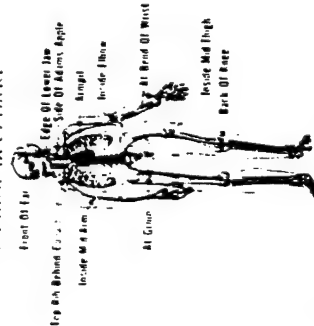
Heat stroke is characterized by a flushed face and hot skin. Person often becomes unconscious. (See page 16.)

Treatment:

- Get person to a cool place. Elevate the upper part of the body.
- Remove as much clothing as is necessary to apply cold cloths to head and body.
- Continue applying cold cloths until consciousness returns or until body temperature returns to near normal.
- Watch for signs of shock and treat if necessary. (See page 13.)
- When person is conscious, give cool water.
- Give NO stimulants.
- Refer to a physician as quickly as possible.

HEMORRHAGE (External Bleeding)

FOR SEVERE BLOOD LOSS TO CONTROL, APPLY PRESSURE TO BLEEDING.



Apply finger pressure on artery against underlying bone at a pressure point immediately above wound.

Use tourniquet **ONLY** when other control methods for bleeding have failed.

Refer to physician.

(Continued)

TOURNIQUET WARNING:

- Once the tourniquet has been applied leave it until a physician removes it.
- Make certain tourniquet is tight enough to stop bleeding.
- Do not apply dressing over tourniquet.
- A notation should be made and attached to the injured person giving the site of the tourniquet and time of application.

INSECT BITES

To relieve the discomfort caused by the bite or sting of bees, mosquitos, wasps, or flies, apply a Sting-Kill swab if a first-aid kit is available.

Alternate procedure: Apply weak ammonia water or a paste of baking soda and water.

If the stinger is left in the wound, withdraw it.

If swelling and pain persist, refer to a physician.

Any individual with a history of being sensitive to insect bites should be sent to a physician immediately.

NOSEBLEED

Have person sit quietly with head tilted slightly forward to prevent blood from accumulating in throat.

Loosen collar.

Wring out cloths wet with cold water and apply over nose, pressing the nostril on the bleeding side against the central portion of the nose for 4 or 5 minutes.

Instruct person not to blow nose for hour or two after bleeding has stopped.

Severe or repeated nosebleed requires medical attention.

POISONS

Identify the poison, estimate the amount taken, and save all containers to assist treatment. After initial emergency care has been given, get the victim to a hospital without delay.

Administer artificial respiration, if needed.

Keep victim warm and quiet.

Take other actions advised by Poison Control Center.

(Continued)

DO NOT induce vomiting **IF:**

- a) The victim has ingested strong corrosives which have burned the mouth and throat, or has ingested petroleum products (kerosene, gasoline);
- b) The victim is unconscious, semi-conscious, convulsing or has convulsed;
- c) The victim is pregnant; or
- d) The victim has severe heart disease.

In most other cases, prompt cleansing of the stomach through vomiting is indicated. Collect and save vomitus for hospital evaluation.

To induce vomiting, administer 1 tablespoon of syrup of ipecac followed by several glasses of warm water or soft drinks. (Vomiting is more effective if stomach is partially full.)

Vomiting usually begins in five to fifteen minutes. If syrup of ipecac is not available, vomiting may be induced by tickling the back of the victim's throat with a finger or the blunt end of a spoon, fork or knife.

Keep victim's head low and turned to side during vomiting to prevent his breathing in vomitus.

If victim is conscious but lips, mouth, and tongue **ARE STAINED AND BURNED** by corrosives, acid or alkali:

Do **NOT** force vomiting.

Dilute by having the victim drink a glass of water or milk if he is conscious and not having convulsions. Discontinue dilution if it makes him nauseated.

Refer to a hospital or physician without delay.

POISONING FROM CONTAMINATED FOOD:*Prevention:*

Keep lunch as cool as possible, out of sun and away from any heat source.

Be careful what you carry in lunch, particularly in hot weather.

Medical office personnel can advise you about this.

Treatment:

Give lukewarm water by mouth to help flush out stomach.

Treat for shock. (See page 13.)

Refer to a physician.

POISON IVY, POISON OAK, OR POISON SUMAC*Prevention:*

Be able to recognize plant and avoid contact with it.

Wear long sleeves and trousers when there is a possibility of being exposed to the plant.

After exposure, you may be able to prevent rash by washing the exposed skin with laundry soap and water and then applying rubbing alcohol.

Treatment:

Wash thoroughly with soap and water.

Apply calamine ointment or lotion or caladryl to itching area.

If the eruption persists, spreads, or is severe, refer to a physician.

PUNCTURE WOUNDS*SLIGHT:*

Encourage bleeding by mild pressure.

Wash with soap and water.

Apply sterile dressing.

Check to see whether person has had tetanus immunization.

SEVERE: (Wound that penetrates into underlying tissues)

Control bleeding with sterile compress.

Apply sterile dressing.

Refer to physician for treatment. This type of injury can result in tetanus and other serious infection.

NOTE: Tetanus (lockjaw) immunization is available at all TVA medical offices and health stations. All employees should receive this protection and should carry immunization records with them to enable doctors treating injuries to know whether to give antitoxin or "booster" shots of toxoid. Cooperating examining physicians, when requested on form TVA 424, will also give booster shots.

SHOCK**FOLLOWING INJURY:**

Control bleeding if present. (See page 10.)

Keep person comfortably warm.

(Continued)

Remove all foreign bodies from mouth.

Loosen tight clothing.

Place person in lying-down position with his feet higher than his head (except in chest injury or suspected head fracture).

Relieve pain as much as possible.

Give artificial respiration if indicated. (See page 17.)

Refer to a physician.

ELECTRICAL SHOCK:

Break contact with electrical conductor, turn off switch if possible. If this cannot be done, stand on a folded dry coat or newspaper or a dry board. With one hand protected by several thicknesses of dry cloth or newspaper, or with a dry stick or pole, grasp a dry part of victim's clothing and drag him away from the conductor. It may be possible to push a live wire off the victim with a dry wooden stick, or to pull the victim off a live wire with a piece of dry rope or your belt looped over the foot or hand.

If victim is not breathing, start artificial respiration immediately and check for circulation. Continue resuscitation as needed until breathing is restored or until physician indicates no further need or until you become exhausted. (See pages 17-18.)

Call for physician.

After victim is revived, apply sterile dressing to burns.

Refer to a physician.

SLIVERS AND SPLINTERS

If the sliver is near the surface and can be grasped with the forceps or fingers, remove and treat the wound as a puncture wound. (See page 13.)

If the skin is deeply punctured by a foreign object, tetanus may result. (See page 13.)

Do not attempt to remove deeply imbedded objects.

Refer to a physician.

SNAKE BITE (Poisonous)

Treat as follows:

1. The victim should remain calm, avoid exertion, and do nothing which would stimulate blood circulation (no alcohol).

(Continued)

2. Apply a constriction band two or three inches above the bite (between the bite and the heart) just tight enough to insert a finger beneath it. This band should not stop blood flow. This band should be left in place until medical help is obtained.
3. Wash the area around the fang marks with soap and water and gently squeeze any blood or venom from the wound that might be present.
4. Do not cut the skin or apply ice.

Snake antivenom is one of the most effective treatments for snakebites when administered by qualified professional personnel. However, there is considerable risk of severe allergic reactions to the drug and its use by lay personnel is not recommended.

SPRAINS

Occur when ligaments supporting a joint or connecting bones are torn.

Treatment:

Elevate the injured part and apply cloths wrung out in cold water or an ice pack.

A firm cravat bandage made from a triangular bandage is useful in supporting the injured part until it can be examined by a physician.

If in any doubt as to the extent of the injury, treat it as a fracture.

Refer to a physician.

STRAINS

Occur when muscle fibers are torn.

Prevention:

Proper lifting and use of body mechanics.

Get assistance in moving heavy weights.

Treatment:

Put injured part at rest.

Apply cloths wrung out in hot water.

Refer to a physician.

TOOTH AND MOUTH INJURIES

FRACTURED JAW:

Gently place the jaw in position so that the upper and lower teeth are together.

Stabilize jaw by supporting with a triangular bandage tied at the top of the head.

Remove gauze if patient has any breathing difficulty or becomes nauseated or unconscious.

Apply ice pack to affected side to control swelling and pain. Give available medication for severe pain.

Refer to physician or hospital.

FRACTURED AND INJURED TEETH:

Isolate fractured or loose teeth with gauze pads.

Close teeth to hold in place.

Give available medication for pain.

Refer to dentist.

INJURIES TO TISSUES INSIDE MOUTH:

Use standard methods for controlling bleeding as indicated by nature of wound. Wrap index finger in sterile gauze; apply direct pressure. Use cold packs for bruised lips.

Bleeding from recent extraction site:

Place several layers of 2" gauze over bleeding site.

Close teeth firmly together to apply pressure for 10-15 minutes; repeat as necessary.

Refer to dentist.

TOOTHACHE:

Give available medication for pain.

Do not place aspirin or other medication that is designed for ingestion on the tooth or gum.

Refer to physician.

UNCONSCIOUSNESS

Unconsciousness may be caused by a number of things such as heart failure, stroke, diabetic coma or insulin shock, epilepsy, excessive drinking, inhalation of toxic gases, head injuries, internal hemorrhage, etc.

Any unconscious person, except a person who has a head or neck injury, should have his neck lifted and his head tilted backward (Continued)

as in figure 2, page 17. If unconsciousness is due to a head injury the airway can be opened by thrusting the lower jaw forward into a jutting out position, the jaw thrust method. (Figure A, page 17).

If possible, determine the cause of unconsciousness and treat accordingly.

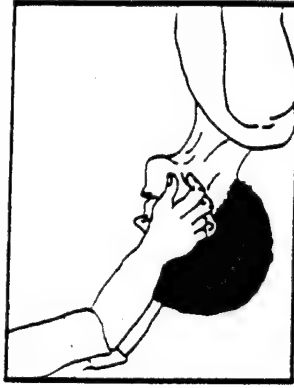
Give nothing by mouth.

Do not move the person more than is necessary.

If breathing has stopped, start artificial respiration.

Treat for shock. (See page 13.)

Get medical care at once.



(Figure A)

CARDIOPULMONARY RESUSCITATION

1. **DETERMINE IF VICTIM IS UNCONSCIOUS** - Tap or gently shake victim's shoulder and shout - "Are you O.K.?" Call out - "Help!"



(Figure 1)

2. **OPEN AIRWAY** - Place one hand beneath the victim's neck and the other hand on the forehead. Gently lift the neck while pressing firmly on the forehead. This should open the airway. Place your ear near the victim's mouth and nose. **LOOK** at the chest for movement, **LISTEN** for breaths and **FEEL** for breathing against your cheek. If the victim is not breathing you should proceed to the next step.



(Figure 2)



(Figure 3)

3. **GIVE FOUR QUICK FULL BREATHS** - Keep the head tilted and pinch the nose.

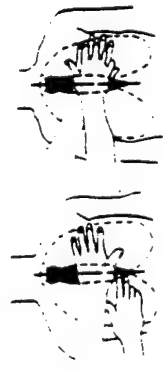
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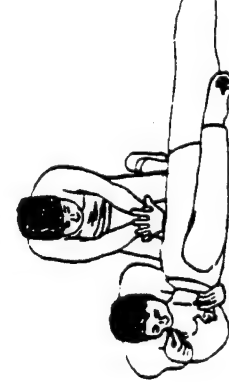
(Figure 4)

4. CHECK FOR PULSE - While keeping the head tilted with pressure on the forehead check the pulse for at least 5 seconds but no more than 10 seconds. Place your finger tips on the Adam's apple and slide your fingers into the groove at the side of the neck nearest you. If there is a pulse but no breathing give one breath every 5 seconds. If there is no pulse or breathing send someone to call an ambulance.

5. FIND THE CORRECT HAND POSITION FOR CHEST COMPRESSIONS - With your middle and index fingers trace the rib cage to the notch where the ribs and breastbone meet. Place the middle finger on the notch and the index finger next to it. Put the heel of other hand on the breastbone next to your fingers. Put the first hand on the top of the hand on the breastbone. Keep your fingers off the chest.



(Figure 5)



(Figure 6)

6. PUSH 15 - BREATHE, 2 - Give 15 compressions at a rate of 80 per minute. Tilt the head and give 2 quick full breaths. Continue to repeat 15 compressions followed by 2 compressions. Check the pulse and breathing after 1 minute and every few minutes thereafter.

FIRST-AID KITS AND SUPPLIES

FIRST-AID KITS

	TVA Stock No.
First-Aid Kit, 16-unit size (filled)	11375
First-Aid Case for 24-unit kit (empty)	11370
(Order contents extra. This kit is for use only on heavy-duty line maintenance trucks.)	

SUPPLIES FOR FIRST-AID KIT

Item	TVA Stock Number	Number of Packages to 16-Unit Size	Number of Packages to 24-Unit Size
Bandage, compress, Telfa, 3 in., 2 per unit	11290	1	1
Bandage, gauze, 4 in. x 6 yds.	11240	1	1
Bandage, triangular, 40 in. wide	11160	2	2
Blanket, rescue, 56 in. x 84 in.	11392	0	1
Calomine ointment, 1/8 oz. tube, pkg. of 6 tubes	11120	1	1
Cold Pack	11220	1	1
Compress, 24 in. x 72 in.	11250	1	2
Compress, plastic, Telfa, 16 to pkg.	11210	2	3
Cresote burn wash, 6 vials per unit	11050	0	1
Eye dressing kit, 1 oz. bottle eye wash solution, 2 eye dressing pads, 2 sets adhesive strips	11260	1	1
Forceps and scissors	11230	1	1
Plaster, adhesive, 1/2 in. x 2-1/2 yds., 2 spools per pkg.	11270	1	1
Soap, anti-bacterial	34405	0	1
Swabs, Betadine (Povidone-iodine), 10 per unit	11060	1	2
Swabs, Sting-kill, 10 per box	11130	1	2
First-Aid Instructions Handbook	11090	1	1

A-14.4 **ATTACHMENT: DA Form 285 (Jan 92) - U.S. Army Accident Report**

U.S. ARMY ACCIDENT REPORT Instructions

General. The unit having the accident must investigate it and complete this report. Complete the shaded portions only for: Military on-duty, on-fatal accidents; and military on-duty accidents resulting in less than 20 lost workdays. Accidents involving 20 or more lost workdays and/or total property damage of \$2,000 or more will require completion of the entire report. Type or legibly print the report. Items may be continued on a blank sheet of paper and attached to the report. Items listed below are keyed to the block numbers of DA Form 285, May 91. Items not listed here are self-explanatory. Specific questions concerning this form should be referred to the local safety office.

SECTION A - Accident Information

Note: This section should be completed for the initial report and for any changes to a previously submitted report.

1. Check "INITIAL" if this is the first report on the accident. Check "CHANGE" if this report is a change to a previously submitted report of the accident.

2. Enter the 6-digit Unit Identification Code (UIC) for the unit responsible for the accident (e.g., WXXXXX).

3. Provide military unit information for the unit listed in Block 2.

a. Full military address (e.g., C Troop, 17 Cavalry, Ft. Bragg, NC 12345-6789).

b. Provide the unit branch (e.g., Armor, Infantry, Transportation).

4. Enter the year, month, and day of the accident (e.g., 90 11 07 (7 November 1990)).

5. Enter the military time the accident occurred (e.g., 0815, 2300).

6. Check either item a or b, depending on the location of the accident.

a. If item a is checked, state name of post or installation (e.g., Ft. Bragg, NC, Federal Center, Atlanta, GA; Ft. Hood, TX; Shaw AFB, SC).

9. Check item a if accident occurred in a theater of hostile fire or enemy action, but not as a result of such interaction. This includes direct preparation for combat, actual combat, or redeployment from a combat theater.

10. Check "Yes" if explosives (C-4, TNT), ammunition, or pyrotechnics were involved and explain in Block 63 its involvement and specify the National Stock Number (NSN).

11. Give enough detail to find the exact location of the accident (e.g., building number, street or highway name, state and/or country). Also state the type of location (e.g., road intersection, tank trail, family housing, firing range).

SECTION B - Personnel Information

Note: Complete this section for each individual involved and/or injured in the accident. "Involved" means any person who was injured, or who took actions, or made decisions which caused or contributed to the accident. If more than one person was involved, enter information on one person on the initial form and complete only Sections A and B on additional forms for others. Staple all forms together.

16. Enter individual's rank/grade (e.g., E5/SGT, O3/CPT, GS-11, WG-8). Complete for all Government personnel.

17. Enter individual's full MOS/Job Series (e.g., 54E20, 11B40, GS-301).

18. Provide individual's full Military address for Government personnel. If this address is not the same as that in Block 3a, provide the unit.

21. State how many continuous hours without sleep this individual was on-duty prior to the accident.

22. Indicate how many hours of continuous sleep this individual had in the past 24 hours.

23. State the estimated number of days this individual will be away from work (totally unable to perform any work and rest in quarters). Does not include days hospitalized.

24. State the estimated (or actual) number of days this individual is hospitalized (inpatient/admitted) receiving treatment. Days hospitalized for "observation only" are not reported.

25. State the estimated number of days this individual will not be able to perform his or her regular duties (light duty, profile).

26. Check appropriate block. If more than one applies, check the most severe.

28. For this individual's "most severe injury", check the appropriate block(s) (no more than 3) that indicate the cause of the injury.

29. Number the body part(s) most seriously injured (no more than 3) in their order of priority (the most serious first). Be as specific as possible.

30. For each body part numbered in block 29, place a corresponding number to indicate the type of injury received (select only the most serious).

31. Check the appropriate block that best describes the individual's action at the time of the accident. If Block 31gg is checked, complete Blocks 76 and 77 of Section H, as indicated by these instructions.

32. Provide a short but detailed explanation of the item checked in Block 31.

Note: For this report, the following definitions apply:

Tactical Training - Training in a field environment that uses or develops combat or combat support skills.

Field Exercise and Tactical Training - This begins when the individual reports to his or her primary duty location for movement to the field site and ends when he or she arrives back at the primary duty location from the field.

33. Check "Yes" if activity listed in Block 31 was part of a field exercise. State name of exercise if it has a name (e.g., Team Spirit, Reforger).

42. If vision enhancement device(s) were used, specify type and model numbers, and whether they caused the accident (e.g., Night Vision Goggles, AN/PVS5A).

43. Provide standard or reference (Soldier's Manual, AP, TM, etc.), if it exists, that covers performance of the activity identified in Block 31.

46. Provide a simple explanation of the mistake(s) or how the activity or task was performed incorrectly (e.g., SGT Smith improperly backed his M915 truck without a ground guide).

47. In your opinion, why was the mistake made or the activity performed incorrectly? Check the most important reason.

51. Check the block corresponding to the piece of equipment associated with the person in Block 12 (e.g., SGT Adams was driving the "at-fault" HMMWV, his name will be in Block 12 and his vehicle will be item 3 in Section C below).

SECTION C - Property/Material Involved

Complete Blocks 52-59 on each piece of property or item of equipment involved in the accident (whether damaged or not). Include Army and non-Army, as well as equipment whose use or misuse contributed to the accident. Include up to 3 items of equipment on the initial form. Use additional blank sheets of paper for other equipment if necessary, continuing letter sequence (e.g., A, B, C, D, and E).

52. Type of equipment (e.g., sedan, truck, generator).

53. Full military equipment model number or civilian make (e.g., M105A2, M60A2, Ford, Lotus, M16, etc.).

55. Estimated cost of damage (ECOD), or actual cost of damage (ACOD) for each piece of property, which includes costs of parts and labor.

57. Indicate if this specific item was being towed at the time of the accident.

58. If Block 57 is "yes", indicate which item was doing the towing.

60. Complete for each component or part whose failure or malfunction contributed to the accident. Include the EIR/QDR number in Block 60e.

61. Indicate how and why each component (part) failed or malfunctioned by summing from the lists provided and entering the appropriate number in the blocks provided.

SECTION D - Environmental Conditions Involved

62. Check the environmental conditions present at the time of the accident (no more than 3) by checking appropriate blocks, whether contributory to the accident or not. Also check whether they caused or contributed to the accident.

SECTION E - Accident Description/Narrative

63. Fully describe the sequence of events that lead up to and caused the accident. Explain how and why the accident occurred. Also include information required from Blocks 10 and 47.

SECTION F - Corrective Action and Command Review

Note: The level of command review (Company, Battalion, Division, etc.) is determined by either the major Army command (MACOM) or installation policy.

65. Fully describe all actions taken, planned, or recommended to eliminate the cause(s) of this accident. Actions should be identified as appropriate at unit level and all the way up to HODAs level.

SECTION G - SAFETY OFFICE USE ONLY

71. MACOM responsible for this accident (FORSCOM, TRADOC, etc.).

SECTION H - Special Interest/Supplemental Information

This section is for use by the U.S. Army Safety Center, MACOMs, or interested safety offices to obtain additional "Special Interest/Supplemental Information" on this accident as needed (e.g., AT tank fires, tactical parachute accidents, etc.). Blocks 76 and 77 have been designated for collection of supplemental information on parachuting accidents.

Blocks 76 and 77. If Block 31gg was checked, provide the following supplemental information for each individual.

- Name of jumper.
- Jumper height.
- Jumper weight.
- Type of jump (static line, non-tactical; static line, mass technical freefall; non-tactical; freefall, tactical).
- Type of parachute and model.
- Jumper's equipment (list).
- Weight of equipment.
- Wind direction and speed at:
 - Jump height.
 - Drop zone.
- Jump altitude.
- Jumper's position in stick and door exited.
- Time pre-jump conducted.
- Date of last jump and type of jump.
- Number of previous jumps.
- Date graduated from basic airborne training (year and month).
- Type of aircraft.
- Accident cause(s): Improper exit, static line injury, broken static line, parachute malfunction, entanglement, loss of stowage, oscillation, unstable position, dragged on DZ, hard landing, drop zone hazard (specify), or other.

U.S. ARMY ACCIDENT REPORT

NOT USE IN THIS FORM: DA FORM 285-40. THE PREVIOUS EDITION IS OBSOLETE.

FOR USASC USE ONLY

Requirement Control Symbol
CSOCS-308

SECTION A - ACCIDENT INFORMATION

1. CHECK ONE <input type="checkbox"/> a. INITIAL <input type="checkbox"/> b. CHANGE			2. UIC (Unit Identification Code) (6-Digit Code of Unit Having Accident)		3. UNIT NAME AND MILITARY ADDRESS		3a. BRANCH (Armor, Infantry, etc.)	
4. DATE OF ACCIDENT a. YR b. MO. c. DAY			5. TIME OF ACCIDENT (Local Military Time)		6. PERIOD OF DAY (Check one) <input type="checkbox"/> a. Day <input type="checkbox"/> b. Night		7. ACCIDENT OCCURRED (Check one) <input type="checkbox"/> a. On Post <input type="checkbox"/> b. Off Post	
8. IF ON POST, NAME OF INSTALLATION/FACILITY			9. ACCIDENT OCCURRED DURING (Check one) <input type="checkbox"/> a. Combat <input type="checkbox"/> b. Non-Combat					
10. WERE EXPLOSIVES OR AMMUNITION INVOLVED OR PRESENT? <input type="checkbox"/> Yes (See instruction book) <input type="checkbox"/> No			11. EXACT LOCATION OF ACCIDENT (Detailed enough to locate site) (State type of location.)					

SECTION B - PERSONNEL INFORMATION

12. NAME (Last, First, MI)			27. CLASSIFICATION AT TIME OF ACCIDENT (Check)		28. CAUSE OF INJURY/OCCUPATIONAL ILLNESS (Check the most serious)	
13. SOCIAL SECURITY NUMBER (SSN)			14. AGE		29. BODY PART(S) AFFECTED (Check primary (No more than 3))	
15. SEX (Check) <input type="checkbox"/> a. Male <input type="checkbox"/> b. Female			16. RANK OR GRADE		17. MOS OR AGR SERIES	
18. ADDRESS (Use Official Address for All Military or Government Personnel if different than block 3, add UIC.)			20. FLIGHT STATUS (Check one) <input type="checkbox"/> a. YR <input type="checkbox"/> b. No		21. DAYS HOSPITALIZED (Est. no. of days hospitalized receiving treatment; not for observation only)	
19. DUTY STATUS AT TIME OF ACCIDENT (Check one) <input type="checkbox"/> a. On Duty <input type="checkbox"/> b. Off Duty			22. HRS SLEEP IN LAST 24 (Without sleep)		23. DAYS LOST (Est. no. of days lost from work; not counting day of injury; not return quarters)	
24. DAYS OF RESTRICTED WORK ACTIVITY (Est. number of days person cannot perform regular duties, night duty/prime)			25. SEVERITY OF ILLNESS/INJURY (Check One) <input type="checkbox"/> a. Fatal <input type="checkbox"/> b. Permanent Total Disability. Person can never again do useful work. <input type="checkbox"/> c. Permanent Partial Disability. Person loses or can never again use a body part. <input type="checkbox"/> d. Days away from work. Person misses time in more workdays; does return quarters. <input type="checkbox"/> e. Restricted Work Activity. Person is temporarily unable to perform regular duties, night duty/prime. <input type="checkbox"/> f. First Aid Only. Person has one-time treatment of minor injury (No lost work days). <input type="checkbox"/> g. No injury.		26. TYPE OF INJURY/ILLNESS (Check the most serious)	
27. Foreign Nat. Direct Hire			28. Foreign Nat. Indirect Hire		29. Foreign Nat. Attached to the U.S. Army	
30. Foreign Nat. KATUSA			31. Public		32. Not reported	
33. Burns (Chemical)			34. Burns (Thermal)		35. Amputation	
36. Decompression sickness			37. Asphyxiation (Suffocation)		38. Fractures	
39. Dislocation			40. Contusion		41. Puncture Wound	
42. Abrasions			43. Concussion		44. Sprain/Strain	
45. Cuts/Lacerations			46. Contusion		47. Puncture Wound	
48. Frostbite			49. Heat Stroke		50. Heat Exhaustion	
51. Noise Induced Hearing Loss			52. Other (Specify)		53. Other (Specify)	

SECTION B - PERSONNEL INFORMATION (Continued)

48. Time licensed on this vehicle (Check one)		49. Total AMV driving mileage (Check one)		50. Total time in unit (Check one)	
a	Less than one year	a	Less than 1,000 miles	a	Less than 6 months
b	One to two years	b	1,000 - 5,000 miles	b	6 months - 1 year
c	Over two years	c	5,000 - 10,000 miles	c	Over one year
d	Unlicensed	d	Over 10,000 miles		

51. WHICH ITEM FROM SECTION C APPLIES TO THE INDIVIDUAL NAMED IN BLOCK 12? (This is needed in order to relate the person in block 12 to the equipment/vehicle below.)

☐ Item A ☐ Item B ☐ Item C ☐ OTHER (Specify)

SECTION C - PROPERTY/MATERIAL INVOLVED (Whether Damaged or Not)

	ITEM A	ITEM B	ITEM C
52. Title of item			
53. Model number			
54. Ownership (DDO EA POV Unit Person)			
55. Dollar cost of damage			
56. Rollover protection system installed?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
57. Was this item being towed?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
58. If towed, enter letter for item being towed			
59. Types of collision codes (Pick up to three from list below and enter in blocks.) (in sequence)			
Types of Collisions 1 - Going forward and collided with moving vehicle 2 - Going forward and collided with parked vehicle 3 - Collision while backing 4 - Collision with pedestrian 5 - Collision with object (other than vehicle/pedestrian) 6 - Overturned 7 - Ran off the road 8 - Jackknifed 9 - Going forward and rear-ended moving vehicle 10 - Going forward and rear-ended parked vehicle 11 - Collision while turning 12 - Other (Specify)			

60. Component/Part that Failed/Malfunctioned (Complete this section if a material failure/malfunction caused/contributed to the accident.)

	ITEM A	ITEM B	ITEM C
a. National Stock Number			
b. Part Number			
c. Describe Part			
d. Manufacturer's Identification Code			
e. EIR/QDR Number			

61. How/Why Part Malfunctioned (Select code from How list below and enter in first block. Select code from Why list and enter in second block.)

HOW	WHY	HOW	WHY	HOW	WHY

How Part Failed/Malfunctioned Codes

1 - Overheated/burned/melted	9 - Twisted/torqued
2 - Cracked (temperature)	10 - Compressed/nib/punctured
3 - Obstructed/pinched/clogged	11 - Bent/warped
4 - Vibrated	12 - Sheared/cut
5 - Rubbed/worn/ravaged	13 - Decayed/decomposed
6 - Corroded/rusted/pitted	14 - Electric current action
7 - Overpressured/burst	15 - Unknown/Other
8 - Pulled/stretched	Blank - Not reported

Why Part Failed/Malfunctioned Codes

1 - Improper equipment design
2 - Inadequate maintenance
3 - Inadequate manufacture of equipment
4 - Inadequate written procedures (AR, TM, SOP)
5 - Improper supervision
6 - Unknown
7 - Other (Specify in narrative)

SECTION B - PERSONNEL INFORMATION (Continued)

31. Person's activities at time of accident (Check one and explain in Block 32.)

a. Submarine	j. Test/Study/Experiments	k. Fabricating	aa. Hobbies
b. Combat Soldiering	l. Education	l. Handling Material/Passengers	bb. Passenger
c. Physical Training	m. Information and Arts	m. Junior/Intermediate/General Keating	cc. Human Movement
d. Weapons Firing	n. Food and Drug Inspection		dd. Horseplay
e. Engineering or Construction	o. Laundry/Dry Cleaning Services	v. Food/Drink Preparation	ee. Overstating/Speculating
f. Camouflage	p. Pest/Plant Control	w. Supervisory	ff. Personal Hygiene/Food/Drink Consumption/Sleeping
g. Security/Law Enforcement	q. Operating Vehicle or Vessel	x. Office	gg. Parachuting (See instructions)
h. Fire Fighting	r. Handling Animals	y. Counseling/Advisory	
i. Patient Care (Postmortem)	s. Maintenance/Repair/Service	z. Sports	

32. SPECIFIC DESCRIPTION OF ACTIVITY/TASK

33. ON FIELD EXERCISE (Check one)
☐ a. Yes (If YES, specify name of exercise)
☐ b. No

34. ACTIVITY PART OF TACTICAL TRAINING? (Check one)
☐ a. YES
☐ b. NO

35. Type of training facility being used (Check one)

a. Garrison	d. NTC	g. Std. range facility live fire
b. Local training area	e. JRTC	h. Other (Specify)
c. Major training area	f. CMTC	

36. Type of training participating in at the time of accident (Check one)

a. School (Specify)	
b. Unit	(1) Platoon (2) Crew (3) Individual
c. On-the-job training	d. Other (Specify)

37. Last time individual received training prior to accident on activity specified in Block 31? (Check one)

a. 0 - 3 months	u. 1 - 2 years
b. 3 - 6 months	v. More than 2 years
c. 6 - 9 months	w. Never
d. 9 - 12 months	x. Not applicable

38. Required protective equipment

CHECK APPROPRIATE BLOCK(S)	AVAILABLE?		USED?		N/A
	YES	NO	YES	NO	
a. Seat belt					
b. Helmet					
c. Goggles/glasses					
d. Gloves					
e. Ear plugs					
f. Other (Specify)					

39. INDIVIDUAL LICENSED TO OPERATE VEHICLE/EQUIPMENT? (Check one)

<input type="checkbox"/> a. Yes	<input type="checkbox"/> b. No	<input type="checkbox"/> c. N/A
---------------------------------	--------------------------------	---------------------------------

40. DID ALCOHOL CAUSE/CONTRIBUTE TO THIS ACCIDENT? (Check one)

<input type="checkbox"/> a. Yes	<input type="checkbox"/> b. No	<input type="checkbox"/> c. Unknown
---------------------------------	--------------------------------	-------------------------------------

41. If drugs caused/contributed to this accident, check appropriate block.

a. Prescription	3. YES (Specify type/model in c and d.)
b. Illegal	d. No
c. Over-the-counter	e. TYPE
d. None	f. MODEL

43. Standard/Reference covering activity/task

a. Soldier's Manual (Task No.)	
b. CTT (Task No.)	
c. AR/TM/FM (Specify)	
d. SOP	e. None (Go to Block 45.)

44. WAS ACTIVITY/TASK PERFORMED IAW STANDARD/REFERENCE? (Check one)

<input type="checkbox"/> a. Yes	<input type="checkbox"/> b. No (If NO, complete blocks 45-47)
---------------------------------	---

45. DID INDIVIDUAL MAKE A MISTAKE? (Check one)

<input type="checkbox"/> a. Yes (If YES, complete blocks 46-47)	<input type="checkbox"/> b. No
---	--------------------------------

46. What was the mistake? How was the activity/task performed incorrectly? (Explain below.)

47. Why was mistake made/activity performed incorrectly? (Check the most important reason and specify in Block 48.)

a. Inadequate school training (content/schedule)	i. In a hurry	l. Inadequate services
b. Inadequate unit training (content/schedule)	j. Poor/bad attitude	m. Improper equipment design
c. Inadequate on-the-job training (content/schedule)	k. Lack of resources	n. Inadequate written procedures (AR, TM, SOP)
d. Faulty equipment	l. Effects of alcohol/drugs	o. Improper supervision
e. Overconfidence in own/other's abilities	m. Inadequate technique	
		p. Other (Specify in narrative)

SECTION D - ENVIRONMENTAL CONDITIONS INVOLVED

62. Environmental conditions. (Check environmental conditions present and indicate if condition caused/contributed to the accident.)

PRESENT	CAUSED/ CONTRIBUTED	CONDITION	PRESENT	CAUSED/ CONTRIBUTED	CONDITION
		a. Clouds, visibility unknown			k. Wind gust/turbulence
		b. Bright, glare			l. Visible, slushy snow, shade
		c. Dark rain			m. Radiation laser sunlight
		d. Fog, condensation, mist			n. Poles, rocky rough, tilted, uneven
		e. Mist, rain, sleet, hail			o. Inclined/sloped
		f. Snow, ice			p. Slippery (not due to precipitation)
		g. Dust, fumes, gasses, smoke, vapors			q. Air pressure (barometric, decompression, altitude, hypoxia)
		h. Noise, bang, static			r. Lightning, static electricity, ground
		i. Temperature/humidity (cold, heat)			s. OTHER (Specify)
		j. Storm, hurricane, tornado			

SECTION E - ACCIDENT DESCRIPTION/NARRATIVE (From blocks 10, 47)

63. GIVE THE SEQUENCE OF EVENTS THAT AMPLIFY/EXPLAIN WHAT HAPPENED, LEADING UP TO AND INCLUDING THE ACCIDENT. (Explain why accident happened.)

64a. PRINTED/TYPED NAME OF PERSON COMPLETING THIS REPORT

64b. RANK

64c. TITLE

SIGNATURE

64e. DATE OF SIGNATURE
(YY/MM/DD)

64f. TELEPHONE NO.

SECTION F - CORRECTIVE ACTION AND COMMAND REVIEW

5. DESCRIBE THE ACTIONS TAKEN, PLANNED, OR RECOMMENDED TO ELIMINATE THE CAUSE(S) OF THIS ACCIDENT (from unit report up to HQDA).

66a. PRINTED/TYPED NAME OF COMMANDER

66b. RANK

66c. SIGNATURE

66d. DATE OF SIGNATURE
(YYMMDD)

66e. TELEPHONE NO.

a. TYPED NAME

b. SIGNATURE

c. TITLE

d. RANK / DATE

67

68

SECTION G - SAFETY OFFICE USE ONLY

70. LOCAL REPORT NO

71. MACOM

72. ACCIDENT TYPE (Check choice)

a. Army Motor Vehicle

h. Other Army Vehicle

o. Personal Injury - Other

b. Army Combat Vehicle

i. Fire

p. Property Damage - Other

c. Army Operated Vehicle

j. Chemical Agent

q. POV - On Official Business

d. POV - Not on Official Business

k. Explosive

r. Space

e. Marine Diving

l. Missile

s. Commercial Carrier/Transportation

f. Marine Underway

m. Radiation

g. Marine Not Underway

n. Nuclear

73. NAME OF SAFETY POINT OF CONTACT (POC)

74. PHONE NO OF SAFETY OFFICE POC
(AUTOVON Commercial, etc.)

75. DATE REPORT COMPLETED BY
SAFETY OFFICE (YYMMDD)

SECTION H - SPECIAL INTEREST AND/OR SUPPLEMENTAL INFORMATION

76

77

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A-14.5 **ATTACHMENT: TVA Safety Program - Management Practice/Serious
Accident Investigation**



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TITLE

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USERS: ALL EMPLOYEES

Approved by

Date

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1.0 PROCESS DESCRIPTION

This practice defines the process for investigating serious accidents in TVA including initial accident notification, assignment of an investigation team, conduct of investigation, reporting, communication of findings and recommended solutions, and follow-up activities.

2.0 OBJECTIVE

The objective is to ensure that a thorough investigation is conducted by establishing the facts related to the accident, determining the factors that caused or contributed to the accident, and determining the actions to prevent a recurrence. The objective is not to place blame on individuals or organizations but rather to identify why failures occur and to ensure appropriate corrective actions.

3.0 EVALUATION CRITERIA

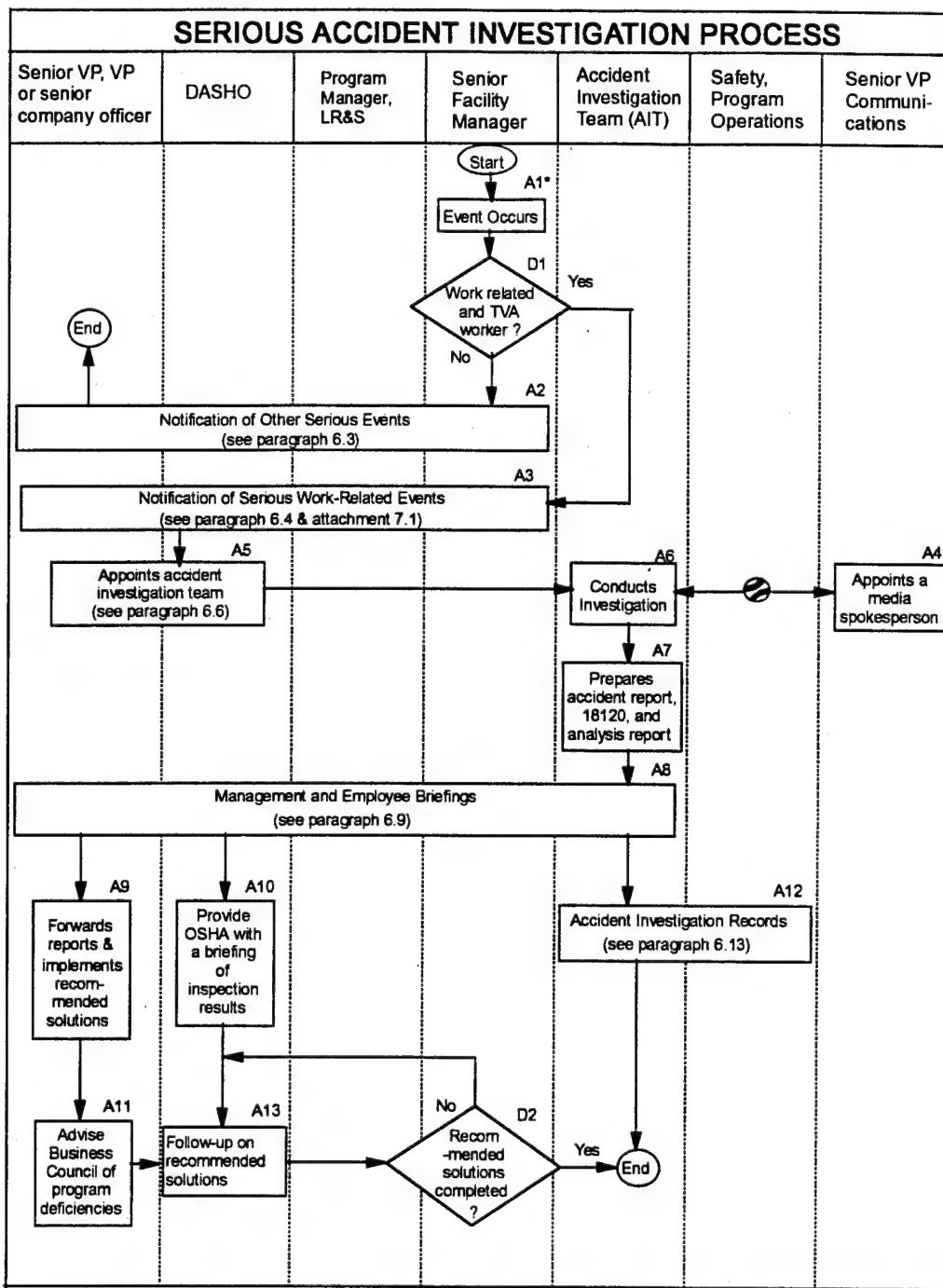
3.1 The Designated Agency Safety and Health Official (DASHO) shall review each serious accident investigation to ensure that all steps in the process are completed, the investigation adequately identifies contributing factors/causes, and recommended solutions are implemented to prevent a recurrence.

4.0 REFERENCES

4.1 Title 29, Code of Federal Regulations, Part 1960, "Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters," (defines "serious accidents" and establishes reporting requirements for accidents defined as serious).

4.2 TVA Safety Program - Management Practice/Reporting and Investigating Injuries/Illnesses.

5.0 FLOWCHART



* Alpha-numeric designations provide a means of referencing portions of the flow chart in the text to follow.



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6.0 PROCEDURE

6.1 Event (Activity Box A1)

This practice applies to all serious accidents that result in any of the following occurrences. EXCEPTION--Radiological control and nuclear operational safety incidents subject to other specific reporting and investigation requirements are investigated by TVA Nuclear (TVAN) as required by applicable procedures.

6.1.1 Serious Work-Related Events

6.1.1.1 A fatality or in-patient hospitalization of three or more TVA employees within 30 days of an accident.

6.1.1.2 Accidental damage to TVA property with an estimated value of \$250,000 or more excluding operating losses.

6.1.1.3 Any event which under slightly different circumstances would have met the criteria in 6.1.1.1 or 6.1.1.2 or may meet these criteria in time. An accident will be defined as serious under this provision upon agreement by the DASHO and the senior vice president, vice president, or senior company officer.

6.1.2 Other Serious Events (require notification but not investigation in accordance with this procedure)

6.1.2.1 TVA employee fatality occurring during nonwork status.

6.1.2.2 Serious accident involving contractor employees.

6.1.2.3 Fatalities to members of the public on TVA property.

6.2 Decision Diamond D1

For serious work-related events go to paragraph 6.4. For other serious events go to paragraph 6.3.

6.3 Notification of Other Serious Events (Activity Box A2)

Other serious events as defined under paragraph 6.1.2 shall be immediately reported by the senior site manager to the appropriate senior vice president, vice president, or senior company officer and the Program Manager, Labor Relations and Safety (LR&S) (see attachment 7.1 for telephone numbers). The senior vice president, vice president, or senior company officer will ensure that the Board; appropriate company officer; and Senior Vice President, Communications, are



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notified. However, these events are not required to be investigated in accordance with this procedure.

6.4 Notification of Serious Work-Related Events (Activity Box A3)

6.4.1 The senior manager at the site of the accident shall:

6.4.1.1 Immediately notify the senior vice president, vice president, or senior company officer and the Program Manager, LR&S, as required in attachment 7.1. The notification shall include the accident location, time of the accident, name(s) of the individual(s) involved, the extent of the injuries, the name and telephone number of a contact person, and a brief description of the occurrence. The Program Manager, LR&S, must be notified as soon as possible so TVA can comply with the OSHA eight-hour reporting requirement.

6.4.1.2 Secure the accident scene to prevent any disturbance of the evidence and to protect people and property from any hazards associated with the accident until the scene is released by the Accident Investigation Team (AIT) chairperson.

6.4.1.3 Identify all witnesses to the accident and obtain, where possible, preliminary witness statements. Witnesses should only be asked to state what happened in obtaining factual information concerning the accident. Other detailed questions will be asked by the AIT.

6.4.1.4 Photograph, if possible, the accident scene.

6.4.2 The senior vice president, vice president, or senior company officer will notify the TVA Board and the appropriate company officer (see attachment 7.1)

6.4.3 The Program Manager, LR&S, makes the notifications listed in attachment 7.1.

6.5 Media Spokesperson (Activity Box A4)

6.5.1 The Senior Vice President, Communications, will select a spokesperson to deal with the press and other members of the public during the accident investigation process. This person will serve as liaison between the AIT and the media for release of additional information.

6.5.2 The "Accident Report" (paragraph 6.8.2) may be released to the media after senior vice president, vice president, or senior company officer review and approval. After release of the report, the AIT chairperson will be available to the media to answer questions.



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6.6 AIT Appointment (Activity Box A5)

LR&S will maintain a list of several managers (PG10 level and above) from each line organization that are trained in accident investigation methodology. Managers on this list should also have a knowledge of quality improvement techniques.

6.6.2 Membership

The DASHO, in consultation with the senior vice president, vice president, or senior company officer of the organization where the serious accident occurred, will appoint an AIT to include:

- 6.6.2.1 One line manager from within the organization where the accident occurred other than the facility where the accident occurred. This manager will be selected as the chairperson. This manager will be on the list of trained managers discussed under 6.6.
 - 6.6.2.2 Two line managers from the facility where the accident occurred.
 - 6.6.2.3 The safety manager from the organization's central staff.
 - 6.6.2.4 Two line managers from organizations other than where the accident occurred. At least one of these managers will be selected from the list of trained managers discussed in 6.6.1.
 - 6.6.2.5 A representative for the DASHO. In addition to responsibilities as a team member, this individual provides advice relative to interpretation of this practice and provides expertise relative to accident investigation techniques. This team member will represent the DASHO during the investigation process.
- ##### 6.6.3 Advisors
- 6.6.3.1 A representative from the General Counsel (GC). This individual provides advice and expertise on legal aspects of the investigation.
 - 6.6.3.2 If preliminary evidence indicates, the AIT chairperson may request assistance from the Inspector General's (IG) office.
 - 6.6.3.3 If preliminary evidence in a fire indicates arson, the AIT chairperson will request assistance from the TVA Police.
 - 6.6.3.4 Others with appropriate expertise as needed, such as engineers, fire protection engineers, etc. If the service of advisors are secured to assist in the investigation, they will perform tasks delegated by the chairperson. They will provide results of studies, tests,



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examinations, etc., to the chairperson and be prepared to answer questions by the AIT.

6.7 Conduct of the Investigation (Activity Box A6)

6.7.1 The scope of the investigation will include:

6.7.1.1 A complete determination and thorough analysis of the facts, circumstances, and conditions related to the accident.

6.7.1.2 The factors that caused or contributed to the accident.

6.7.1.3 An evaluation and determination of the actions necessary to ensure this accident (or similar type accident) does not recur.

6.7.2 Investigation Methodology

6.7.2.1 The AIT will report to the accident scene as soon as possible but in no case later than the day following the accident.

6.7.2.2 The AIT chairperson will brief team members on: (1) the purpose and scope of the investigation, formats, time constraints, etc., (2) background and preliminary details of the accident, (3) status of the accident scene (security, existing hazardous conditions, necessary precautions, personal protective equipment needed, operational needs for the investigation, etc.), and (4) arrangements for clerical and other administrative support.

6.7.2.3 The AIT will use analytical techniques, such as the TQM six-step problem solving methodology, Event Critique and Root Cause Analysis, Fault Tree Analysis, and Management Oversight and Risk Tree (MORT), in arriving at its opinions and recommended solutions. Whatever technique used should look at both programmatic and physical causes related to the accident. Specific additional instructions may be given to the AIT by the senior vice president, vice president, senior company officer, or the DASHO.

6.7.2.4 All evidence should be secured and maintained as part of the accident investigation file and classified as administratively confidential.

6.7.2.5 Interviews will be taped and later transcribed and/or a court reporter may be used. If there is any question about whether an injured employee can be interviewed, Health Services shall be consulted. All interviews are considered confidential by TVA.

6.8 Reports (Activity Box A7)

6.8.1 The Accident Report shall be completed by the AIT within five working days of the occurrence. This report contains only factual information



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and can be released for public information (see Attachment 7.2 for an example Accident Report cover and distribution).

6.8.2 The AIT is responsible for completing the form TVA 18120, Injury/illness Investigation Report, within six working days. If necessary, the 18120 will be revised to include causal information that was not available when the 18120 was first submitted to LR&S.

6.8.3 The "Accident Analysis Report" (2d report) shall be completed by the AIT within 30 working days of the occurrence. If 30 working days is not feasible, a time extension must be approved by the senior vice president, vice president, or senior company officer and the DASHO. This report will provide an in-depth analysis of the accident to identify all root causes and contributing factors. The analysis will consider all possible physical and programmatic causes. This report includes the final listing of opinions and recommended solutions. This report is administratively confidential (see Attachment 7.3 for an example Accident Analysis Report cover and distribution).

6.9 Management and Employee Briefings (Activity Box A8)

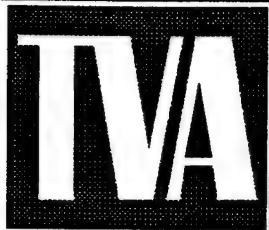
6.9.1 The AIT chairperson will provide copies of the accident analysis report to the senior vice president, vice president, or senior company officer; DASHO; and Manager, Safety. A briefing will be scheduled to present the results of the investigation. At the discretion of the senior vice president and DASHO, they may invite others as appropriate.

6.9.2 As soon as possible following the briefing in 6.9.1, the senior vice president, vice president, or senior company officer; DASHO; Manager, Safety; and the AIT chairperson will brief the affected senior company officer if not included in the briefing in 6.9.1.

6.9.3 As soon as possible following the briefing in 6.9.2, the senior vice president, vice president, or senior company officer; DASHO; and the AIT chairperson will brief the Executive Committee.

6.9.4 The senior vice president, vice president, or senior company officer will send copies of the final report to the Chief Operating Officer; Chief Administrative Officer; President, TVAN; the senior manager at the site where the accident occurred; the GC; Manager, Safety; and the DASHO. The DASHO will ensure that the agency health and safety committee is briefed on the accident at the next scheduled meeting.

6.9.5 The senior vice president, vice president, or senior company officer will ensure that managers and employees at the facility where the accident occurred are briefed on the investigation results within 60 working days of the occurrences. If investigation results are applicable to other TVA employees, additional briefings may be scheduled as necessary.



LOCATION
TENNESSEE VALLEY AUTHORITY

PROCEDURE NUMBER
TVA/DASHO/STD/ALL/x.x

TITLE

REV. 0

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6.10 Share Information and Implement Recommended Solutions (Activity Box A9)

6.10.1 The senior vice president, vice president, or senior company officer will assign responsibilities for implementing and following up on recommended solutions to ensure efficient and timely implementation. The senior vice president of all TVA organizations will review the recommended solutions and be responsible for replication of corrective actions as appropriate within their organization. The DASHO will be responsible for monitoring this effort.

6.10.2 The senior vice president, vice president, or senior company officer will ensure that preliminary findings and recommended solutions that might be applicable to other TVA facilities and work locations are promptly disseminated throughout the agency. The DASHO will provide assistance as needed and monitor related activities to ensure adequate sharing of information.

6.11 OSHA Report (Activity Box A10)

The DASHO shall provide OSHA, Office of Federal Agency Programs, with a briefing of the accident investigation. This briefing shall include: date/time of accident; agency/establishment name and location; accident consequences; a description of the operation, accident, causal factors; and agency corrective/preventive actions.

6.12 Advise Business Council (Activity Box A11)

The senior vice president, vice president, or senior company officer will advise the Business Council of agencywide implications or any program deficiencies identified by the investigation.

6.13 Accident Investigation Records (Activity Box A12)

6.13.1 After completing the investigation and briefing, the AIT chairperson will send all accident investigation materials to Safety, Program Operations, MPB 1B, Muscle Shoals, AL 35662-1010.

6.13.2 Safety, Program Operations, will retain all original AIT investigation documentation in TVA's serious accident repository file. Release of any part of the accident file will require DASHO authorization.

6.14 Follow-up on Recommended Solutions (Activity Box A13, and Decision Diamond D2)

The DASHO, as part of corporate oversight responsibility, will periodically follow-up on AIT recommended solutions until all are completed, as well as assess the effectiveness of this practice.



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7.0 ATTACHMENTS

7.1 Serious Accident Notification Contact List

7.2 Example, Accident Report Cover and Distribution

7.3 Example, Accident Analysis Report Cover and Distribution



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Attachment 7.1 **SERIOUS ACCIDENT NOTIFICATION CONTACT LIST**

Senior manager at the facility/site where the accident occurred contacts:

1. Senior vice president/vice president/or senior company officer
2. Program Manager, Labor Relations and Safety (Tommy Lucas)
Office: 423/632-7753 (during business hours)
Home: 423/524-3723 (after hours)
Pager: 1-800-443-7243 (24 HOURS)
 - Wait for voice prompt and enter access code 032182
 - Wait for a beep - enter your area code and 7 digit phone numberAlternate: Manager, Safety (Gene Walters)
Office: 423/632-7756
Home: 423/922-3679

Senior vice president/vice president/or senior company officer contacts:

1. TVA Board: 423/632-2531
2. As appropriate, contact either:
Chief Operating Officer: 423/632-3108 or 423/751-7572
Chief Administrative Officer: 423/632-4765
President, TVA Nuclear: 423/751-4470
Chief Financial Officer: 423/632-3987

Program Manager, LR&S, contacts:

1. OSHA Area Office: 423/781-5423 or 1-800-321-OSHA
2. Designated Agency Safety and Health Official (DASHO): 423/632-7870
3. General Counsel: 423/632-7038
4. Inspector General: 423/632-4120
5. Employee Assistance Program: 432/751-2850
6. Assistant Administrator of the Tennessee Valley Trades and Labor (T&L) Council: 615/885-4323
7. Appropriate T&L Craft Representative
8. Chairperson, Salary Policy Panel: 423/751-8604
9. Teamsters Union: 706/861-2160
10. Senior Vice President, Communications: 423/632-8018



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Attachment 7.2 Example, Accident Report Cover and Distribution

June 8, 19XX

Senior Vice President, Vice President, or Senior Company Officer

ACCIDENT REPORT, FATAL INJURY TO JOHN DOE, JUNE 4, 19XX

Attached is the "Accident Report" concerning the fatality of John Doe, Building Maintenance. This report was prepared by an accident investigation team consisting of the following members.

Name	Job Title and Organization

(Name)

Accident Investigation Team Chairperson

Attachment

cc: Designated Agency Safety and Health Official
General Counsel
Inspector General (As appropriate)
Senior Manager at Site Where Accident Occurred
Chief Operating Officer
Chief Administrative Officer
President, TVA Nuclear
Chief Financial Officer
Senior Vice President, Communications
Manager, Safety



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Attachment 7.3 Example, Accident Analysis Report Cover and Distribution

ADMINISTRATIVELY CONFIDENTIAL

ACCIDENT ANALYSIS REPORT

FATAL INJURY TO JOHN DOE

BUILDING MAINTENANCE

June 4, 19XX

SUBMITTED BY:

R. A. King, NP
Chairperson

Date

AIT MEMBERS:

1. C. J. Peoples, BM
2. J. J. Holland, BM
3. O. W. Lawson, NP

DISTRIBUTION:

TO: Senior Vice President, Vice President, or Senior Company Officer;
Designated Agency Safety and Health Official; Manager, Safety; General Counsel;
and Senior Manager at Site where Accident Occurred.

This report has been developed to allow improvements in TVA's safety program.
This report will not be reproduced.

A-14.6 **ATTACHMENT: U.S. Department of Labor Form CA-1 (Nov. 89) - Federal Employee's
Notice of Traumatic Injury and Claim for Continuation of Pay/Compensation**

Federal Employee's Notice of
Traumatic Injury and Claim for
Continuation of Pay/Compensation

U.S. Department of Labor
Employment Standards Administration
Office of Workers' Compensation Programs



Employee: Please complete all boxes 1 - 15 below. Do not complete shaded areas.

Witness: Complete bottom section 16.

Employing Agency (Supervisor or Compensation Specialist): Complete shaded boxes a, b, and c.

Employee Data

1. Name of employee (Last, First, Middle)				2. Social Security Number	
3. Date of birth	Mo.	Day	Yr.	4. Sex <input type="checkbox"/> Male <input type="checkbox"/> Female	5. Home telephone ()
6. Grade as of date of injury				Level	Step
7. Employee's home mailing address (include city, state, and zip code)				8. Dependents <input type="checkbox"/> Wife, Husband <input type="checkbox"/> Children under 18 years <input type="checkbox"/> Other	

Description of Injury

9. Place where injury occurred (e.g. 2nd floor, Main Post Office Bldg., 12th & Pine)

10. Date injury occurred	Time	11. Date of this notice	12. Employee's occupation
Mo. Day Yr.	<input type="checkbox"/> a.m. <input type="checkbox"/> p.m.	Mo. Day Yr.	

13. Cause of injury (Describe what happened and why)

Nature of injury (Identify both the injury and the part of body, e.g., fracture of left leg)	a. Occupation code	
	b. Type code	c. Source code
	OWCP Use - NOI Code	

Employee Signature

15. I certify, under penalty of law, that the injury described above was sustained in performance of duty as an employee of the United States Government and that it was not caused by my willful misconduct, intent to injure myself or another person, nor by my intoxication. I hereby claim medical treatment, if needed, and the following, as checked below, while disabled for work:

- ☐ b. Continuation of regular pay (COP) not to exceed 45 days and compensation for wage loss if disability for work continues beyond 45 days. If my claim is denied, I understand that the continuation of my regular pay shall be charged to sick or annual leave, or be deemed an overpayment within the meaning of 5 USC 5584.
- ☐ a. Sick and/or Annual Leave

Signature of employee or person acting on his/her behalf

Any person who knowingly makes any false statement, misrepresentation, concealment of fact or any other act of fraud to obtain compensation as provided by the FECA or who knowingly accepts compensation to which that person is not entitled is subject to civil or administrative remedies as well as felony criminal prosecution and may, under appropriate criminal provisions, be punished by a fine or imprisonment or both.

Have your supervisor complete the receipt attached to this form and return it to you for your records.

End of Employee Report

Witness

16. Statement of witness (Describe what you saw, heard, or know about this injury)

Name of witness	Signature of witness	Date signed
Address	City	State Zip Code

**A-14.7 ATTACHMENT: TVA Form 9179 (4/88) - Claims of Disability for Work Due to job-
Related Injury**

**CLAIMS OF DISABILITY FOR WORK DUE TO JOB-RELATED INJURY:
NOTICE OF EMPLOYEE'S RESPONSIBILITIES**

According to regulations of the Federal Employees' Compensation Act (FECA), as revised effective June 1, 1987, if you are claiming disability for work due to a job-related injury, you have certain obligations as listed below.

1. **FILE A CLAIM PROMPTLY** - Complete the employee's side of claim form OWCP CA-1 and submit it to your supervisor as soon as possible, but **NO LATER THAN THIRTY DAYS AFTER THE DATE OF INJURY**.
2. **SUBMIT MEDICAL EVIDENCE** - Submit to TVA within 10 workdays medical evidence of disability for work due to the claimed injury.
3. **INFORM YOUR DOCTOR OF TEMPORARY LIGHT DUTY** - Inform your doctor of any offer by TVA to provide temporary light duty, where possible, to accommodate medical constraints imposed by the claimed injury.
4. **INFORM YOUR DOCTOR OF ALTERNATE JOBS** - Inform your doctor of any particular alternate jobs made available by TVA, and furnish the doctor with any written description of the specific duties and physical requirements of such jobs furnished by TVA.
5. **INFORM TVA IMMEDIATELY OF ANY MEDICAL LIMITATIONS OR CONSTRAINTS SPECIFIED BY YOUR DOCTOR**.
6. **RETURN TO WORK** - You are obligated to return to regular duty as soon as you are able to do so. **ALSO**, you are obligated to accept suitable offers by TVA of temporary light duty or alternate jobs not in conflict with medical limitations caused by the claimed injury.
7. **REPORT ALL EMPLOYMENT AND SELF EMPLOYMENT ACTIVITIES** - For all periods in which you claim COP or Compensation you are required to report all employment and self employment activities. You must report the activities performed and the income earned. Earned income for employment activities is defined as actual salary, wage, sales commissions, piecework commissions, and other payments of value such as housing allowances, meals, food, clothing, equipment, reimbursed expenses, etc. Additionally, if you performed activities in connection with a relative's or spouse's business, you must report as earned income what it would have cost the employer or organization to hire someone to perform the work you performed. For self employment activities, earned income is defined as the gross income received from the activity. If the self employment activity was operated at a loss or if the profits were reinvested you must report what it would cost to hire someone to perform the work you performed.

According to the FECA, WHERE AN EMPLOYEE REFUSES SUITABLE WORK offered by the employing agency according to FECA regulations, ENTITLEMENT TO COP CEASES as of the effective date of availability of such work.

Where an employee FAILS TO SUBMIT THE REQUIRED MEDICAL EVIDENCE WITHIN 10 WORKDAYS or REFUSES SUITABLE WORK, COP SHALL BE TERMINATED.

I have been informed of and understand the employee's responsibilities listed above.

EMPLOYEE'S SIGNATURE

DATE

OFFICIAL SUPERIOR'S SIGNATURE

DATE

PENALTIES UNDER 20 CFR, SECTION 10.23 ARE SHOWN ON THE BACK OF THIS SHEET.

A-14.8 ATTACHMENT: TVA Form 255 (1/90) - Report of Vehicle Accident, Theft, or Fire
(TVA Vehicle Only)

REPORT OF VEHICLE ACCIDENT, THEFT, OR FIRE

Instructions

Prepare report immediately after occurrence. For accident or fire involving TV-00001 through TV-49999 send 3 copies to Transportation Services, Chattanooga and for TV-50000 through TV-99999 send 3 copies to Heavy Equipment Department, Chattanooga. For theft send 2 copies to Transportation Services or Heavy Equipment Department as appropriate and third copy to nearest TVA Public Safety Office. Always send 1 copy to employee's supervisor. Supervisor completes Supplement (pages 3 and 4) and distributes all four pages according to the instructions at the bottom of page 4.

TVA DRIVER

Payroll Name	Age	Social Security Number	TVA Telephone
Plant, Facility, Department			Group or Organization
Supervisor's Name	Title	TVA Address	TVA Telephone
Responsible Manager	Title	TVA Address	TVA Telephone

TIME AND LOCATION

Date Occurred	Hour	Street or Road	City and State
---------------	------	----------------	----------------

TVA VEHICLE

Make	Model	Body Type	License Number
------	-------	-----------	----------------

DAMAGE TO VEHICLE

Description of Damage	Estimated Amount
	\$

DISPOSITION OF TVA VEHICLE

Still in Service	Left at TVA garage or other
------------------	-----------------------------

PROPERTY OF OTHERS

Kind Of Property And Extent Of Damage				
				Estimated Amount
				\$
If Automobile	Make And Year	Body Type	License Number	State
Owner Of Property		Address		Telephone
Where Property Can Be Seen				

OTHER DRIVER

Other Car Driver's Name	Address	Occupation	Telephone
Insurance Carried By		Kind Of Insurance	
Driver Owner None		Liability Collision Medical	
Name Of Insurance Company			

PASSENGERS

Full Name	Age	Address	TVA NONTVA
1			
2			
3			

OTHER WITNESSES

1	
2	
3	

PERSONS INJURED IN ACCIDENT

1	
2	
3	
4	
Nature And Extent Of Injuries	
Doctor's Name	
Place Injured Were Taken	

	Lights On (specify which)	Signals Given (specify which)	Speed (mph)													
			When Danger First Noticed	At Impact	Legal Limit											
TVA VEHICLE (Owned or rented)																
OTHER VEHICLE																
TVA Restraining Devices	Lap Belt Installed Lap Belt Worn	<table border="1"> <tr><td>yes</td><td>No</td></tr> <tr><td></td><td></td></tr> </table> Shoulder Belt Installed Shoulder Belt Worn	yes	No			<table border="1"> <tr><td>yes</td><td>No</td></tr> <tr><td></td><td></td></tr> </table> Prevented Injury	yes	No			<table border="1"> <tr><td>yes</td><td>No</td></tr> <tr><td></td><td></td></tr> </table>	yes	No		
yes	No															
yes	No															
yes	No															
HIGHWAY CONDITIONS	Blacktop On grade	Concrete Level	Gravel-dirt Curve	Wet Open country	Dry Residential	Ice-snow Commercial										
LIGHT	Daylight	Night	Dusk-dawn	Streets lighted												
WEATHER	Clear	Rain	Snow	Fog												
TRAFFIC CITATIONS	OFFENSE CHARGED TO YOU		DISPOSITION	OFFENSE CHARGED TO OTHER DRIVER		DISPOSITION (if known)										
INVESTIGATING OFFICER	NAME			State	City	County TVA										
SKETCH ACCIDENT ON DIAGRAM	<p>1 Write in street names or numbers</p> <p>2 Show traffic signs and control devices</p> <p>3 Show lanes, double yellow lines, center strips, etc</p> <p>4 Show direction and distance to nearest town, major intersection, and landmarks</p> <p>5 Draw and number vehicles involved and parked</p> <p>6 Use solid line to show path before accident and broken line after accident.</p> <p>7 Show pedestrian</p> <p>8 Show railroad</p> <p>9 Show skid marks, and give lengths</p> <p>10 Attach any photos.</p> <p>Indicate North by arrow in circle</p>															
DESCRIPTION OF ACCIDENT THEFT OR FIRE Use additional sheets if necessary	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>															
PRIVACY ACT 1974	<p>In compliance with the Privacy Act of 1974, the following information is provided: Collection of the information is authorized by the Tennessee Valley Act of 1933, 16 U.S.C. 8313d and 40 U.S.C. 491. Disclosure of information is required by TVA regulations (TVA INSTRUCTION II TRANSPORTATION Equipment). An employee of a federal agency who fails to report accurately a motor vehicle accident involving a federal vehicle may be subject to administrative sanctions. The principal purposes for collecting this information are: (1) To provide necessary data for use by legal counsel in any actions resulting from the accident; and (2) To provide accident information and statistics for use in analyzing accident causes and developing methods of reducing accidents. Routine uses include disclosure to federal, state, and local governments and agencies when relevant to civil, criminal, administrative, and regulatory investigations, actions, and proceedings.</p>															

SIGNATURE OF DRIVER

DATE

SUPPLEMENT
ADMINISTRATIVELY CONFIDENTIAL WHEN COMPLETED
CONFIDENTIAL OPINION(S) AND RECOMMENDED ACTION(S) TO
PREVENT RECURRENCE OF
VEHICLE ACCIDENT, THEFT, OR FIRE

SUPERVISOR'S REVIEW, OPINIONS, AND RECOMMENDATION(S)

Supervisor completes this supplement and distributes according to instructions on page four.

Reviewer's Name _____ Date _____ Date of Accident _____

What was happening before the accident?

- ☐ 01 Roadway driving
☐ 02 Off-the-road driving

- ☐ 03 Vehicle being serviced
☐ 04 Vehicle idle

What type of vehicle?

- ☐
- 001 Passenger car/van/wagon

- ☐
- 002 Pickup truck

- ☐
- 003 Compact car _____

- ☐
- 004 Compact pickup truck

- ☐
- 005 Tractor-truck

- ☐
- 006 Other truck

- ☐
- 007 Other type vehicle (specify) _____

Accidents involving damage to other types of vehicles such as industrial forklifts, mowers, scooters, construction equipment not being used as a motor vehicle at the time of the accident, etc., should be reported on form TVA 18002 (Report of Accidental Property Damage, Fire, or Fire Related Incident).

An accident is "Driver-Controllable" if in your opinion the TVA driver could likely have prevented the accident through prudent actions. In your opinion was this accident "Driver-Controllable"? ☐ yes ☐ No

Why? _____

What immediate actions do you recommend be taken to prevent recurrence of a similar accident?

	Recommended Action	Person Responsible	Completion Date
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____

What long-term action(s) do you recommend be taken to prevent a recurrence of a similar accident?

	Recommended Action	Person Responsible	Completion Date
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____

Reviewer signature _____

Next higher level management signature _____

and approval of recommended action(s)

Date _____

Date _____

Use for continuation of narrative or other information which in your opinion is of importance.

Distribution (Send copies of all four pages to)
OC H&S, MPB 1E 207B-M
TVA General Counsel, Knoxville
Transportation Services, Chattanooga (TV-00001 - TV-99999)
Appropriate Heavy Equipment Department (TV-50000 - TV-99999)
Appropriate Responsible Manager

A-14.9 **ATTACHMENT: Form SR-13 (1/93) Alabama Department of Public Safety Accident**
Involving a Private Vehicle

Alabama Department of

Public Safety

Driver License Division
Safety Responsibility Unit
P.O. Box 1471
Montgomery, AL 36102-1471

For Office Use Only

DOC No.

Case No.

COMPLETION OF THIS FORM IS REQUIRED BY §32-7-1, CODE OF ALABAMA 1975.

FAILURE TO FILE A REPORTABLE ACCIDENT ON THIS FORM MAY RESULT IN SUSPENSION OF YOUR DRIVER LICENSE.

INFORMATION AND INSTRUCTIONS: Completion of this form is required ONLY if a motor vehicle accident occurring in Alabama caused death, personal injury, or property damage to any one owner in excess of \$250. The driver of any motor vehicle, which is in ANY MANNER involved in an accident in this state, is legally required to file a report on this form with the Department of Public Safety within ten (10) days after the accident regardless of whether or not at fault and regardless of whether or not the vehicle involved was covered by liability insurance at the time of the accident. If such driver is physically incapable of making such report, the owner of the motor vehicle involved in such accident shall, within ten (10) days after learning of the accident, make such report.

DATE OF ACCIDENT

☐ A.M.
☐ P.M.

NO. OF VEHICLES

For Office Use Only

LOCATION OF ACCIDENT (ST./HIGHWAY)

COUNTY

Subject

Injuries

Claims

VEHICLES INVOLVED

YOUR INFORMATION (PLEASE PRINT OR TYPE)

OTHER PARTY'S INFORMATION (PLEASE PRINT OR TYPE)

YOU ARE THE: ☐ DRIVER ☐ PEDESTRIAN ☐ PROPERTY OWNER ☐ OTHER

OTHER PARTY WAS: ☐ DRIVER ☐ PEDESTRIAN ☐ PROPERTY OWNER ☐ OTHER

NAME (FIRST, MIDDLE, LAST)

TELEPHONE NO.

NAME (FIRST, MIDDLE, LAST)

TELEPHONE NO.

ADDRESS: STREET NO.

ADDRESS: STREET NO.

CITY

STATE

ZIP

CITY

STATE

ZIP

DRIVER'S DATE OF BIRTH

SEX ☐ M
☐ F

DRIVER LICENSE NO.

STATE

DRIVER'S DATE OF BIRTH

SEX ☐ M
☐ F

DRIVER LICENSE NO.

STATE

NAME OF OWNER

IF SAME AS DRIVER,
MARK BOX ☐

NAME OF OWNER

IF SAME AS DRIVER,
MARK BOX ☐

ADDRESS OF OWNER: STREET NO.

ADDRESS OF OWNER: STREET NO.

CITY

STATE

ZIP

CITY

STATE

ZIP

OWNER'S BIRTH DATE

SEX ☐ M
☐ F

OWNER'S DRIVER LICENSE NO.

STATE

OWNER'S BIRTH DATE

SEX ☐ M
☐ F

OWNER'S DRIVER LICENSE NO.

STATE

YOUR VEHICLE

OTHER VEHICLE (Use additional form if more than two (2) vehicles)

YEAR MAKE TYPE COMMERCIAL ☐ YES ☐ NO STATE

YEAR MAKE MODEL TYPE STATE

VIN LICENSE PLATE NO.

VIN LICENSE PLATE NO.

PROPERTY DAMAGE

DESCRIPTION OF PROPERTY DAMAGE (OTHER THAN VEHICLE)

INJURED PERSONS (CLAIM FOR PERSONAL INJURY ON REVERSE)

FULL NAME OF INJURED IN YOUR VEHICLE

DID INJURED ☐ YES
DEP? ☐ NO

ADDRESS: STREET NO.

CITY STATE ZIP

DATE OF BIRTH SEX ☐ M ☐ F INJURED WAS: (Please circle)

☐ DRIVER ☐ PASSENGER ☐ PEDESTRIAN ☐ OTHER

FULL NAME OF INJURED IN YOUR VEHICLE

DID INJURED ☐ YES
DEP? ☐ NO

ADDRESS: STREET NO.

CITY STATE ZIP

DATE OF BIRTH SEX ☐ M ☐ F INJURED WAS: (Please circle)

☐ DRIVER ☐ PASSENGER ☐ PEDESTRIAN ☐ OTHER

INSURANCE AND/OR SECURITY

Complete the following as required by the Safety Responsibility Law of Alabama (§32-7-1 and following sections). Mark only the appropriate box. All information will be verified.

- ☐ 1. No liability insurance in effect at time of accident.
- ☐ 2. Form SR-23 (fleet policy) on file with DPS.
- ☐ 3. Your vehicle is a qualified carrier with APSC. ☐ YES ☐ NO
APSC Certificate No. _____
- ☐ 4. Department of Public Safety Self-Insurance
Certificate No. _____
- ☐ 5. Motor vehicle liability policy issued by

(Name of insurance company, not agency)

POLICY NO. _____

POLICY PERIOD FROM _____ TO _____

POLICY HOLDER _____

A-14.10 ATTACHMENT: Record of Signatures

Notice: All TVA personnel signing the attached document certify they, the undersigned, have read this Health and Safety Plan, understand its contents, and will comply with all provisions contained herein.



**MAAP Cap Extension, Operable Unit Two
O-Line Ponds Area
Contract No. DACA21-94-C-0173
2nd Revision**

[illegible]

**MAAP Cap Extension, Operable Unit Two
O-Line Ponds Area
Contract No. DACA21-94-C-0173
2nd Revision**

[illegible]